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THE ROENTGEN DIAGNOSIS OF RICKETS*

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RECENT attempts have been made to summarize and classify, in orderly sequence, our present knowledge of the roentgen changes of infantile scurvy[2] and congenital syphilis,[16] and the purpose of this paper is to do the same for rickets. In American journals devoted to roentgenology, the rachitic changes have been described in detail, but it seems that little or no effort has been made to arrange them in roentgen sequence. In 1915 Lovett[11] divided the roentgen manifestations of rickets into three stages, but very few references to his work have been found in the literature. Since that time much progress has been made in the knowledge of the disease, largely brought about by numerous studies on its pathogenesis, and the effect of vitamines, light, etc., on its course. The roentgen method of examination was necessary and indispensable for accurate observation and check of the healing effect of these various methods of therapy. The post-war studies of Chick et al.,[3] Wimberger,[23] Plaut,[15] and others, have also been noteworthy contributions. It seems opportune to revise and classify the roentgen changes of rickets based largely upon the original classification of Lovett.

The diagnosis of any disease entity is made with less difficulty when the roentgenologist can recognize on the roentgenogram all changes from the normal, from the slightest sign of the beginning to the most advanced stages, from the very onset of healing through the completion of all reparative processes. A complete knowledge of all roentgen changes, together with the pathological conditions causing them is, of course, presupposed. When the sequence of these changes proceeds in an orderly and logical fashion, their division into stages of progress is a comparatively easy task, but often abortive or mild cases occur which lend themselves with difficulty to such classification. However, a disease process may show several different types of roentgen manifestations, each of which must be followed through to a final healed stage, which tends to complicate the attempted classification. The earlier the roentgen recognition of the disease, the greater is the opportunity for the early institution of therapeutic measures, the patient thus escaping, perhaps, the more severe forms of the disease.

From a roentgenologic point of view the chief interest in the pathogenesis of rickets centers in the roentgen observation of the therapeutic effect of sunlight, ultraviolet radiation, exercise and diet, ergosterol, irradiated foods, etc., upon the clinical and the roentgenographic course of the disease. These therapeutic measures are

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the direct result of a vast research directed toward the pathogenesis of rickets, and a large proportion of this work was accomplished with the aid of the roentgen ray. For the roentgenologist the study of the various theories of the causation of rickets is a time-consuming task as the literature covering its pathogenesis is voluminous. Of far greater importance to him are the clinical manifestations, the recognition of mild and abortive forms, the knowledge of the limitations of roentgen examination of the long bones in mild and early cases, and the roentgen sequence based upon the underlying pathological changes.

CLINICAL MANIFESTATIONS

Rickets is observed usually in the first two years of life, rarely showing itself before the third month and generally not until the sixth month. It may rarely begin after the second year (Griffith and Mitchell)[7]. Dunham[4] reports a case in which the disease was present in an infant thirty-four days old. Still[19] states that rickets is seldom seen after three years of age. Recently Blank and Graves[1] have reported cases of postinfantile rickets associated with osteomalacia, and believe that active rickets is by no means uncommon after the age of three years and before adolescence.

The case of fully developed rickets is not difficult to recognize. Craniotabes, bosses on the head, delay in the closure of the anterior fontanel, distention of the veins of the scalp, beading of the ribs, the characteristic Harrison's groove, deformities of the extremities, epiphyseal enlargements, and other signs, make the diagnosis certain. Craniotabes may also be caused by congenital syphilis which at times may confuse the diagnosis. Marfan[13] believes that syphilis is sometimes a cause of rickets, especially in those cases which are characterized by an early onset, by predominance of cranial lesions, a definitely marked anemia and an accompanying hypertrophy of the spleen.

Of extreme roentgenologic importance is the fact that the early case may show rachitic changes such as craniotabes with beading of the ribs, and yet show no evidence whatever of the disease on the roentgenograms of the long bones. Chick et al.[3] observed 13 infants roentgenologically diagnosed as rickets and 55 infants without roentgen evidence of the disease. Of the 13 showing roentgen changes, 12 had very definite clinical signs of rickets. Of the 55 infants with no roentgen evidence of rickets, 12 had clinical indications sufficient to suggest some degree of rachitic change, such as small areas of cranial tabes, rachitic rosaries, and in one case there was definite cranial bossing. Their conclusions agree with those of Hess and Unger[8] that the enlarged rosary, when scurvy can be excluded, provides a more delicate means of diagnosis than the roentgen films.

Moore[14] has stressed certain early signs: craniotabes; abnormalities of the chest which may assume a square, triangular or an oval form, as measured at the plane of the fifth costochondral junction; costomalacia or softening of the sternal ends of the ribs; genu valgum and genu varum. The latter are always preceded by abnormal lateral mobility of the knee joint, which is often the first sign of leg rickets. Knee mobility can be measured either roughly by hand or more accurately by a simple instrument which he has devised.

From the study of my cases it seems that the clinical finding of a Harrison's groove combined with a mild, or at times even an absent rosary, and lateral mobility of the knee joints, or a genu valgum, is a comparatively frequent one. This is especially the case in mild rickets occurring in children of the better classes. On roentgen examination no evidence of rickets can be found in the long bones. The limitations of the roentgen ray as an aid in the diagnosis of early or even more advanced mild cases must thus be appreciated.

DEVELOPMENT OF BONE

Normal bone growth and its histological appearance have been fully described in a previous communication.[16] Stated briefly for a better appreciation of the pathological process of rickets, on a longitudinal section of the growing end of a long bone, the zone of resting cartilage is first seen on the joint side of the epiphysis. Following this is a layer in which the cartilage cells become increasingly larger, which has usually been called the proliferating cartilage. As this layer approaches the diaphysis the cells become arranged in columns which extend toward the diaphysis, lying parallel to the long axis of the bone. This forms the columnar cartilage layer. The cells of this layer likewise become increasingly hypertrophied, and quite abruptly the zone of temporary or preparatory calcification follows. This is the site of the preliminary deposition of calcium which takes place in the intercellular matrix of the columnar zone. The zone of temporary calcification has a flat line of demarcation in some bones, while in others it may be concave or convex, and shows this same definite demarcation in the roentgenogram as well as in the histological section. The blood vessels in the columnar cartilage run transversely at right angles to the long axis of the bone. The zone of primary spongiosa follows the zone of temporary calcification and is formed of longitudinal islands of ossified cartilage which lie free and isolated in the marrow cavity. The new bone is first laid down as osteoid tissue which differs from mature bone only in the lack of lime salts. Succeeding this is the zone of fully developed bone. The thick ossified trabeculae of the primary spongiosa are soon reconverted, being first absorbed by the osteoclasts and then freshly reconstructed by the osteoblasts. Normally in health only a narrow rim of osteoid tissue is found because of rapid calcification. The fully developed bone (secondary spongiosa) consists of strong trabeculae, the intervening spaces being filled with lymphoid marrow.

Growth in length of bone takes place by elongation of the diaphysis by means of endochondral ossification, and growth in width or thickness by endosteal and periosteal ossification, the latter occurring in the innermost layer of the periosteum. The rate of growth in endochondral ossification is much greater than in periosteal ossification. In rickets, pathological changes reach their greatest manifestation in those portions of the skeleton which grow the fastest (Schmorl,[18] Wimberger[23]). The most rapidly growing bones are the upper ribs at the costochondral junctions, the distal ends of the femur and ulna and the proximal end of the humerus.

Wimberger[24] in his study of bone growth in healthy and rachitic children as shown in roentgenograms, concluded that the normal growth of a tibia when plotted, showed a rather flattened, wave-like line whose highest point was reached in July and the lowest in February.

PATHOLOGY

Marfan[12] states that rickets can be divided into three pathological stages: a period of onset, a period of full development and a period of repair. These three stages do not correspond to any three clinical phases as, for instance, lesions may be in a beginning stage in the tibia while in some bones, such as the ribs, a fully developed stage may exist, and other bones may even show a stage of repair and healing. Rib lesions, because of their more rapidly growing costo-cartilaginous ends, usually attain their greatest intensity at their anterior extremities contiguous to the costal cartilages.

According to Marfan the initial lesions of rickets are generally neglected by most authors who devote their descriptions to the stage of full development. In the first stage the resting cartilage is thickened and the zone of temporary calcification is widened.

These zones have not, on cut section, such sharply defined rectilinear margins as has normal bone. The ossified layers, the primary and secondary spongiosa, show thin trabeculae with enlarged interspaces filled with bone marrow in proliferation which has a red, almost black, color. At times the bone marrow invades the subperiosteal layer of the shaft. Histologically the cartilage is in a state of manifest proliferation. Even in the resting cartilage the cells are very numerous, but more especially is this the case in the zone of proliferating cartilage and the zone of temporary calcification. In the latter the cells are numerous, very large, and may have several nuclei. The line of separation between the proliferating cartilage and the zone of temporary calcification has no sharp histological definition, and it may be somewhat broken. These zones are invaded by blood vessels surrounded by fibrous tissue, and even some connective tissue cells may be seen. The trabeculae are thinned and the secondary spongiosa is much rarefied.

In the stage of fully developed rickets (Marfan), the proliferating cartilage layer is much thickened and its limits are not defined. On the diaphyseal side it encroaches on the zone of temporary calcification and on the opposite side on the layer of resting cartilage. It is cut up into small, irregular blocks and its limits are not rectilinear. The multiplication of cells is more marked than in the beginning stage. The resting cartilage is invaded at points by vessels and fibrous tissue. The zone of temporary calcification is completely broken up and is formed of blocks of columnar cartilage, of fibro-vascular tissue and of cellular marrow. The cartilage cells are enormous in size, their nuclei are very large and are often multiple. The layer of primary spongiosa is also no longer sharply defined, is broad and irregular, and masses of cartilage take up areas which should be completely calcified. Only small areas of calcification can be seen in large cartilaginous areas, where normally there should be uniform calcification. Large vascular channels are formed instead of the comparatively few blood vessels as in normal growing bone, and these vascular channels in places are surrounded by medullary spaces. Inasmuch as rickets is a disturbance of the equilibrium between deposition and absorption of calcium in growing bone, there is an increasing deposition of uncalcified, or the so-called osteoid, bone in place of the normal, calcified bone.

The osteoid bone is characteristic of rickets. The areolae are bounded by a very thin framework, the trabeculae. In the center are found the remains of older uncalcified bone, and at the periphery is a layer of uncalcified bony tissue. The areolae are large, irregular and unequal in size, and are filled with a marrow rich in cells, fibroid in character, consisting of star-shaped or fusiform cells, some red blood corpuscles and pigments derived from the hemoglobin. The medullary cells are almost entirely absent. This fibroid marrow has an invasive, aberrant character, and accumulations of it can be found in the fragmented zone of temporary calcification, in the proliferating cartilage zone and in the columnar cartilage, and sometimes even under the periosteum. Virchow[20] called rickets "parenchymatous bone inflammation," while Wegner[22] called congenital syphilis "osteochondritis" or "cartilage inflammation."

The period of repair (Marfan) begins with a modification of the osteoblasts of the rachitic osteoid tissue. The medullary cells reappear in the fibroid marrow. The zone of temporary calcification reappears. According to Erdheim[5] the zone of temporary calcification in normal ossification maintains a constant shape and depth since during growth, the rate of absorption of the primary growing cartilage is adjusted correctly in relation to the deposition of lime in the zone of proliferating cartilage. Absorption during rickets goes on, sometimes at a reduced rate, but the calcification of cartilage stops entirely, so the zone

of temporary calcification entirely disappears, as described in the fully developed stage. As this zone disappears, the whole process of endochondral ossification becomes disorganized and, as a result, the rachitic osteoid bone is laid down. As the rachitic process goes on in the fully developed stage, the deposition of calcium ceases, the proliferation of cartilage continues and, as this growth proceeds, row after row of cartilage cells are added to the rachitic zone (Schmorl[18]). Deposition of cartilage in the stage of repair does not begin at the old cartilage-bone junction but at the place where it would have taken place if rickets had not developed, that is, at the end of the zone of rachitic proliferation farthest from the shaft (Schmorl[18]). The formation of this new zone of temporary calcification in the stage of repair serves as a check on the rachitic proliferation in the growing cartilage tissue, and normal growth again makes a beginning from the new zone of temporary calcification. Behind this zone increasing calcium deposition goes on in the process of absorption and deposition and thus the osteoid tissue that has been formed during the course of the disease becomes transformed into normal osseous tissue.

If a relapse occurs, as first pointed out by Schmorl, the new zone of temporary calcification will be broken through, and the line of calcification corresponding to the period of healing will be buried in the widened distal portion of the diaphysis. Occasionally several of these buried or partially buried lines of calcification may be seen, indicating as many attempts at healing, with relapse (Fig. 1).

Wimberger[23] found that in rachitic children, for a short time after the appearance of roentgen signs in the tibia, growth was slower and in winter the curve of bone growth definitely fell below that of the normal winter growth. In beginning healing in spring, the growth curve was considerably steeper than the normal. Growth suffered no loss because of infantile

Fig. 1. Illustrates the relapsing type of rickets. Several distinct lines, representing new zones of temporary calcification, can be seen near the diaphyseal extremities.

rickets. The steep ascent of the spring growth he believes can be conceived as a peculiarity of the rachitic convalescence.

In the short bones and in the epiphyseal centers changes analogous to those in the diaphyseal ends take place. The epiphyseal center is irregularly defined, the same aberrant proliferation of the cartilage, especially the columnar cartilage, occurs, and areas of rachitic osteoid tissue can be found. The flat bones show analogous changes but somewhat modified by their own special manner of ossification (Marfan). In the bones derived from connective tissue, as those of the cranial vault (membranous bones), an abnormal vascularization and an excessive proliferation of the bone marrow occur. This is found in the initial stage around the points of ossification and under the periosteum. As a result the bone has a swollen and decalci-

fied appearance. In the stage of fully developed rickets the marrow becomes fibroid, as in the long bones, the trabecular framework is thinned and is covered with rachitic osteoid tissue which is soft and partially decalcified. This tissue forms abundantly under the periosteum, and in the skull the frontal and parietal bones are most affected. This causes the characteristic bosses during the period of repair and healing. Marfan[13] believes mechanical factors such as the weight of the child lying on his back or habitually on the right side, accentuate the rachitic deformities of the skull. The arrest of normal ossification prevents the closure of the sutures and the fontanels within the normal time limits.

ROENTGEN APPEARANCE OF NORMAL LONG BONES

In describing the roentgen appearance of a normal long bone a clear nomenclature is essential which permits no confusion of terms. For this reason the term epiphyseal line will not be used but instead the extremity of the diaphysis will be designated as the diaphyso-epiphyseal junction. The sharp line of demarcation found on the roentgenogram at the end of the diaphysis, usually about 5 mm. in width, appears as a single line of slightly greater intensity than the rest of the shaft. If the roentgenogram shows sharp definition the line may appear double, due to the projection on the film of the boundary of the flat surface of the end of the diaphysis. The sharply defined portions of the line or double line correspond to the zone of temporary calcification. This represents on the film the limit of advancing ossification. It may be convex toward the joint, as at the lower end of the humerus, or concave, as at the lower end of the femur. The diaphysis shows the thick wall of cortex on either side in its middle portion, and the cortex becomes thinned out until, at the diaphyseal extremities, it persists only as a thin line. The marrow cavity lies between the walls of the cortex, and at the ends of the diaphysis it is traversed by the regular network of fine lines, the trabeculae of the spongy bone. The periosteum is not visible in spongy bone.

In the roentgenograms of normal bone, density is determined (Weech and Smith)[21] by the calcified intercellular matrix and the calcified trabeculae. This fact is illustrated by the new line which is formed when rickets begins to heal, and is even better illustrated by the broad dense band which occurs in early congenital syphilis. They found that these areas in the roentgenogram, when compared with histological sections, showed that in each instance the density was due to the calcified intercellular substance.

The resting and proliferating cartilage of the epiphysis is not usually seen in the roentgenogram. The normal center of ossification, after it has made its appearance, has the same sharply defined border as has the extremity of the shaft. In roentgenograms showing excellent soft part detail a faint outline of the cartilage is sometimes visible. In lateral views of the knee joint the border of the lower epiphysis of the femur has a denser appearance than in the anteroposterior projection due to the thickness of the condyles.

ROENTGEN CHANGES

Rickets, when roentgenographically studied, is a disease which can be divided into several types. Thus there are the active and passive forms described by Wimberger,[23] the Manchette (cuff) type and the Becher (beaker) type of Göttche,[6] and the type described by Lovett[11] which is the usual manifestation of the disease but which at times may assume a more severe form. To a certain extent these types overlap and different names in some instances have been applied to the same manifestations.

Wimberger[23] describes two types of florid rickets, the active and the passive. The former is usually found in severe cases,

the child lying on his back and not moving the extremities. The active type is found in those children who show, in spite of their illness, a good state of nutrition and good bodily activity. In the passive type the zone of temporary calcification is thinned out to a marked degree, and shows a frayed out appearance of its edge. This is due to the half calcified trabeculae which can be traced into the resting cartilage of the epiphysis. The zone of temporary calcification no longer has a dense homogeneous, calcified appearance. None of the so-called cupping is present. The spongy bone shows a wide-meshed structure. Wimberger believes that the conditions determining the development of this roentgen type appear to be concerned with the general functional development of the child, since it is found under conditions of both good and bad nutrition. While usually found in the severe cases, it may sometimes occur in those of only moderate severity.

The active type is characterized by the well-known cupping of the ends of the diaphyses. Since this type is found in children showing a good state of nutrition and much bodily and mental activity, the degree of skeletal change is often underestimated until revealed by the roentgen ray. Wimberger has observed the cup-shaped form in children who can crawl and walk, that is, in children whose skeleton has been subjected to mechanical strain before the onset of rickets. In the active type the cupping is most distinct at the distal ends of the radius, ulna and tibia, and the proximal and distal ends of the fibula. In the cases of this series the cupping has also been frequently observed in the distal end of the femur. Wimberger's observation that even in the most severe cases the distal end of the humerus always remains convex has been confirmed by this study. He has seen cases in which the passive form developed into the active after increase of bodily exercise. Transition forms between these two general types occur.

In the cupped form, faint shadows can be seen running longitudinally from the diaphyseal end into the cartilage of the epiphysis, which are due to trabeculae which still retain some calcium and, according to the duration of the disease, to the calcified remains of the old zone of temporary calcification. The excessive cell proliferation and division of the proliferating cartilage of the epiphysis, due to the rachitic process, cast no shadow. Thus, if the bone is actually increased in length, the shadow of the diaphysis remains unaltered at the length it had attained before the onset of the disease. In histological sections the edge of the cupped area is shown as a semicircular envelope which is believed by Wimberger to be due to the calcium protective law of Erdheim. The limited amount of calcium in the rachitic bone is deposited at its periphery, since the long bones suffer the greatest strain at the periphery. The calcium selects for its site of deposition from the large amount of osteoid tissue, the site which offers the greatest available strength resulting from its deposition. The cupping is thus explained on a mechanical basis.

The Manchette (cuff) form described by Göttche[6] is usually the less severe form of the disease, and this type never shows cupping. As healing progresses the osteoid tissue becomes denser and finally a dense homogeneous band appears at the end of the diaphysis very much resembling a cuff. When this appears Göttche considers the bone is fully healed. The interval between the reappearance of the zone of temporary calcification and the appearance of the cuff shadow represents the time necessary for complete healing and can be determined by serial roentgenograms at intervals of two weeks or less.

The Becher (beaker) form is the cupped form, or apparently the active form, of Wimberger. Göttche considers this type a compensatory result of bodily activity and strain. Thus, he has never observed the beaker form in cases where there has been great loss of calcium with poor nutrition

and consequent loss of strength. He found it, for the most part, in children whose bones were not subjected to great calcium loss and more frequently in older than in younger children.

Lovett[11] divided the usual type of rickets into three roentgen stages. In the first stage a frayed-out appearance of the ends of the diaphyses can be seen, the diaphysis contains less lime than normal, but no deformities are present. The epiphyses cast either faint shadows or are completely invisible, the center of ossification is small or absent and at times may seem to be multiple if present. The whole joint is surrounded by a hazy cloud. In the more severe type which he mentions, in addition to all the changes of the usual type, extreme bone atrophy and multiple fractures occur.

In the second stage the ends of the diaphyses, where the strain is the greatest, begin to broaden, the shaft begins to cast a more definite shadow, longitudinal streaking of the region next to the epiphysis can be noted, and a transverse homogeneous area one-fourth to one-half inch in width can be seen immediately behind the line of demarcation of the diaphyseal end on the shaft side. The shadow of the epiphysis becomes better defined, and the epiphyseal center shows a more mottled appearance. In the late second stage he states that a "white line" appears, similar to the "white line" of infantile scurvy, the shaft shows thickening on the concave side, and instead of smooth homogeneous bone, an irregular shadow structure appears which he calls "chambering of the interior of the bone."

This second stage in reality marks the beginning of healing but Lovett's description was not expressed in histological terms. The sign of a beginning sharp demarcation of the diaphyseal end is evidently the reappearance of the zone of temporary calcification, and as its reformation in the reparative process proceeds, the dense line which he states is similar to the "white line" of scurvy is the result, inasmuch as it becomes progressively wider and denser.

In the third stage all bone shadows show better definition, and the clouded condition about the joints has cleared away. The "white line" becomes more pronounced, the thickening on the concavity of the rachitic curves becomes greater, the deposition of lime salts continues and the entire shaft ultimately has the appearance of dense bone. The epiphyseal center resumes its normal contour and normal shadow density and the mottling disappears.

It will thus be seen that the descriptions of the various forms of rickets by these three authors overlap to a certain extent. The purpose of this paper is to separate and clarify these types so as to make the resultant classification of the greatest practical value to the roentgenologist. The criteria which constitute the most practical value for him today probably are: (1) the recognition of the beginning of healing, and (2) the recognition of the fully healed stage. Göttche's statement of the necessity of serial roentgenograms must be emphasized again. Both are necessary for the accurate observation of the course of healing as affected by the one particular therapeutic agent which may be employed by the pediatrician. The recognition of the second is essential in aiding the orthopedic surgeon to determine the proper time for operative intervention, osteotomy, osteoclasis, etc., for the correction of deformities. The classification is based on a first stage covering the period from the onset of beginning skeletal changes on the roentgenogram to the first sign of the reappearance of the zone of temporary calcification, in other words, the first roentgen sign of healing. The second stage includes the healing interval from the reappearance of the zone of temporary calcification to the dense bone stage, which is the stage of complete healing. The third stage (of complete healing) might be termed the stage of residual deformities in those cases which, in previous stages, have developed the characteristic

deformities of rickets. This is the proper time for osteotomy, etc. In the mild cases (Fig. 8) there is only increased density of bone with a broad, wide, dense zone of temporary calcification without any of the usual deformities. If serial roentgenograms are to be used to check the effect of any particular method of treatment, cases should not be used which show, on their first roentgen examination, the reappearance of the zone of temporary calcification. As healing has already begun in these cases the effect of the treatment used cannot, of course, be accurately gauged.

Primarily, two types of rickets must be recognized. The first or the passive type of Wimberger shows no cupping of the diaphyses throughout its course. This type includes both mild and severe cases. The former show few roentgen signs and might be called non-florid rickets. When healed, both the mild and severe cases show either distinctly or, at least suggestively, a resemblance to the Manchette or cuff type of Göttche. The second type, the active of Wimberger, the beaker of Göttche and that described by Lovett in his classification, shows either a frank broadening of the diaphyseal ends or a varying tendency to this characteristic throughout the course of the disease. There may be cases of the first or non-cupped form which, in the early stage, as observed by Wimberger, later develop into the second or beaker type because of increased bodily and muscular activity. These roentgenographic stages do not correspond to any three distinct clinical stages nor can they be absolutely compared to the three histological stages of Marfan. Often the actual diagnosis must be made on clinical signs with an entire lack of any noticeable changes in the roentgenograms of the long bones (Göttche) (Chick).

First Stage, Passive Type. The diaphysis shows a definite diminution in lime content, often having a streaked appearance and the zone of temporary calcification gradually disappears, depending on the severity of the disease process. Fine, thin shadows can be seen running out from the thin, broken line of the disappearing zone of temporary calcification into the resting cartilage of the epiphysis, which are due to half calcified trabeculae (Wimberger). No deformities are present. The cortex of the shaft gradually develops an atrophic appearance, showing varying degrees of thinning. In severe cases multiple fractures are found. No cupping of the diaphyses can be seen. Periosteal proliferation and thickening are occasional findings.

In the epiphysis, in roentgenograms showing excellent detail of the soft parts, an increased width and opacity of the proliferating and resting cartilage can be detected. Faint or moth-eaten outlines of the epiphyseal centers of ossification are present, provided they have already appeared. The distinct limiting border of the center may be entirely absent and the nucleus may appear only as a faint haze, in marked contrast to its ring appearance in infantile scurvy. Plaut[15] concludes that in mild infantile rickets the epiphyseal centers appear on the roentgenogram without visible delay. In moderately severe or very severe rickets no new epiphyseal centers appear on the roentgenogram. They are, however, actually laid down as can be demonstrated histologically but, owing to deficient calcification, they remain invisible until healing sets in. If roentgen examinations are made after repair, when calcium deposition has begun, epiphyseal centers are shown of such size as to indicate their previous existence for several months. In very acute rickets Plaut noted that visible centers became invisible, owing to loss of calcium. Only in acute cases accompanied by severe disturbance of bodily development could he find an actual delay in the development of the centers, and in these cases he noted that much delayed punctiform centers appeared in contradistinction to the sudden appearance of the large centers mentioned above (Fig. 2).

Mild cases show these changes but to a

less marked degree. There is often no streaked appearance of the shaft, the atrophy is scarcely, if at all, noticeable, the

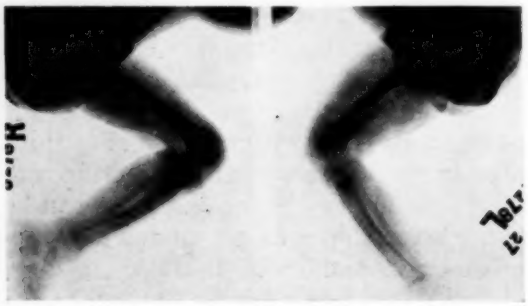

Fig. 2. Pathological fracture of the left femur. Note the thin frayed-out appearance of the zone of temporary calcification of the lower end of the diaphysis of the left femur. The resting cartilage of the lower epiphysis is swollen and enlarged, and the epiphyseal center is scarcely visible. The rachitic process in the left femur is in the first stage, passive type. The right femur and tibia show signs of less severe rickets. The epiphyseal centers are visible. Early signs of cupping of the diaphyseal extremities can be seen.

zone of temporary calcification never completely disappears and roentgen signs are in some cases found only with difficulty.

First Stage, Active Type. In the active type the changes of the passive type are found but in addition cupping appears very early in the onset of the disease. Cases may pass from the passive to the active type, as has been shown by Wimberger (Fig. 3). In the series of cases on which this study is based a large proportion, when first examined, showed definite cupping of the diaphyseal ends, without any perceptible signs of healing. Obviously it is impossible to say whether these cases in the period before roentgen observation were really cases of the passive or non-cupped type. No definite answer can be given to the question whether all cases at first are of the passive type. Since so many cases are examined for the first time with definite cupping present, it seems most practical to include for classification purposes a first stage of the active type.

Second Stage, Passive Type. Period of Repair. In the passive type the zone of temporary calcification, as it reappears, is at first faint but later becomes wider and denser. Between this and the site where the old zone of temporary calcification existed, is a layer of homogeneous appearing bone, containing less calcium, of varying width, which is caused by the osteoid layer of bone. As repair proceeds this gradually assumes a denser appearance. Göttche[6] considers a rachitic bone as healed when the new shaft end attains its usual fine construction which gives it a definite contrast to the coarser structure of the

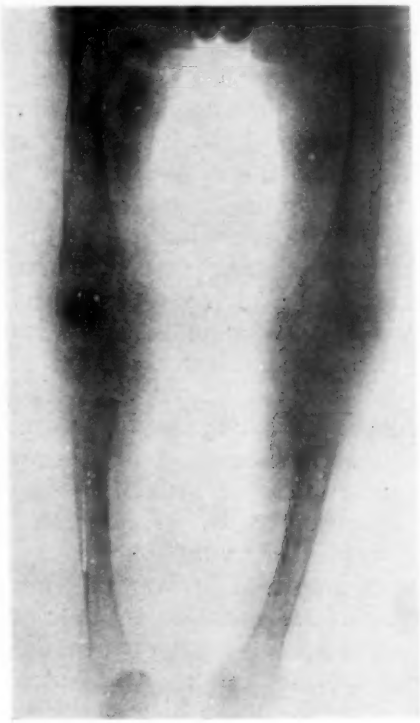

Fig. 3. Illustrates the transition from the passive to the active type, first stage. The lower extremities of the diaphyses of the femurs show no cupping while those of the tibia show slight widening. Beginning curvature of the diaphyses of the tibias is also present. Faint lines, evidently due to new zones of temporary calcification, are shown at the lower diaphyseal ends of the femurs, but are not visible in the tibias, thus showing that the rachitic process in the femurs has developed into the second stage.

Fig. 4. New zones of temporary calcification have been formed about the epiphyseal centers of the heads of the femurs, encircling the osteoid layers of bone.

spongiosa and appears on the roentgenogram as a cuff at the end of the bone. He states that the reappearance of the zone of temporary calcification is often missed and recommends that serial roentgen examinations be made at one week intervals in order not to overlook its reappearance. He also has noted a disappearance a second time of the zone of temporary calcification, when calcium deposition apparently was slow in the healing process. Thus, no absolute statement can be made that the healing process will always be continuous until fully complete.

The time of reappearance of the epiphyseal centers depends on the severity of the rachitic process. In many cases the new zone of temporary calcification can be seen encircling an osteoid layer of bone just as in the diaphyseal ends (Fig. 4). The moth-eaten appearance of the centers becomes more homogeneous and ultimately the bone regains its normal structure. It seems that the osteoid zone of the epiphyseal center usually calcifies at the same rate as the analogous layer in the shaft.

In the active or beaker form healing proceeds with the filling of the cupped end from the bottom to the top of the cup by calcium deposition. Göttche states that in this form the formation of a new zone of temporary calcification often cannot be detected. In patients where the cupping is not marked this has been noted in my series of cases. He often found the most marked beaker form in children who were less severely affected clinically by the disease. In the most severe cases he never found it, thus proving, he believes, the static and mechanical basis for the cupping. He also found it more often in older children. The beaker form is the result of a compensatory bone growth and occurs in most marked degree in bones where such a compensatory effort is possible.

Second Stage, Active Type. In the active form the osteoid layer appears as in the passive form. In addition coarse lines and

Fig. 5. Second stage, active type. Note the new zones of temporary calcification at the diaphyseal extremities of the radius and ulna, with faint osteoid layers of bone between them and the original zones of temporary calcification.

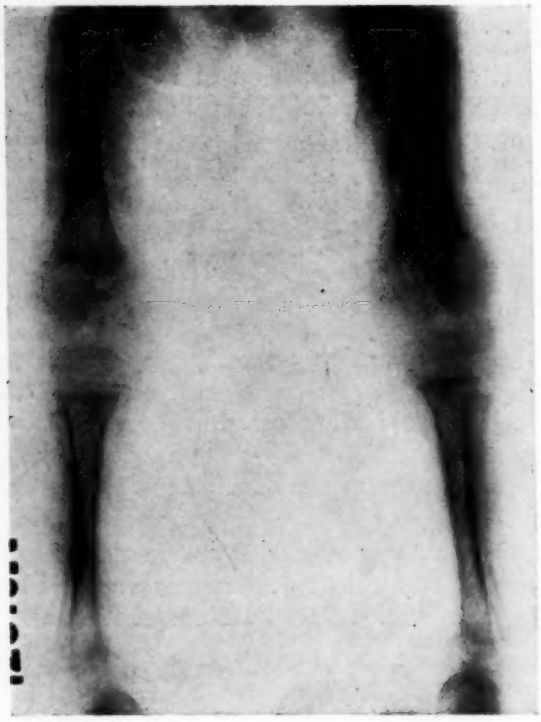

FIG. 6. Second stage, active type. The osteoid zones are more prominent than those shown in Figure 5. The epiphyseal centers are still hazy and indistinctly outlined.

striations appear in the spongiosa on the shaft side of the osteoid layer. Small cystic areas can be found, and this appearance has been called by Lovett chambering of the shaft. Deformities with thickening of the cortex on the concavity of the curve are common (Figs. 5, 6 and 7).

The epiphyseal centers, in addition to the changes described in the passive form, seem to broaden to meet the widened diaphyseal ends. Some show large rarefied areas which are slow in filling in with calcium. The diaphyso-epiphyseal margin often assumes a crescentic shape and in other cases shows a wavy appearance.

Third Stage, Passive and Active Types. The third stage in both types, passive and active, shows the dense, almost eburnated appearance of the cortex of the long bones so easily recognizable on the roentgenogram. The zone of temporary calcification is often very thick, broad and dense. Transverse striations, thin fine lines running transversely across the diaphysis at varying intervals from its ends are often found. These are not pathognomonic of healed rickets but are the result of any disease which at some time has arrested bone growth. The residual deformities which are found show curves with dense, white, thickened cortex on the concavity of the curves (Fig. 8).

In reviewing the cases of this series several which were in the third stage showed fragmentation of bone along the inner border of the lower epiphyseal center of the femur, at the lower inner border of

FIG. 7. Second stage, active type. Smooth homogeneous bands are visible at the diaphyseal extremities, due to more advanced calcification of the osteoid zones. The new zones of temporary calcification are wide and dense, while the old zones are faintly visible, forming the boundaries of the osteoid zones on the diaphyseal sides. The coarse trabeculae of the shafts stand out prominently in contrast to the smooth homogeneous appearance of the osteoid zones.

Fig. 8. Third stage, passive type. Note the slight genu valgum, the dense and wide zones of temporary calcification, and the faint transverse striations. The latter are shown more distinctly in the lower ends of the diaphyses of the femurs.

the diaphysis of the femur, at the inner border of the upper epiphyseal center of the tibia and at the upper and lower inner borders of the diaphysis of the tibia. The fragments as a rule were larger at the diaphyseal borders than were those along the inner borders of the epiphyseal centers. All these cases showed marked curved deformities with genu varum. No reference calling attention to this has been found in the literature. Its frequency strongly suggests that it is the result of the rachitic process. The fragmentation along the epiphyseal border has been noted in routine examinations of the knee joint for other conditions, as in one instance in an examination for a suspected tuberculous arthritis of the knee joint. In this case no other signs of old or healed rickets were found, nor were there any other changes in the bones

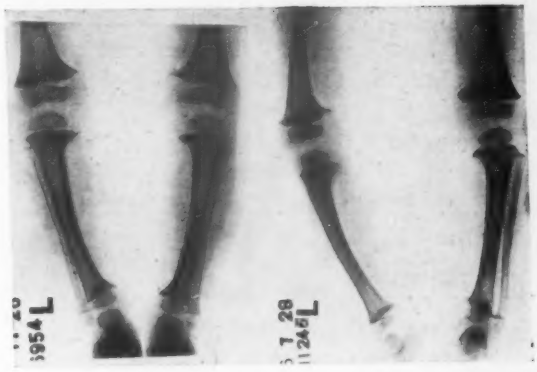

Fig. 9. Third stage, active type. The cortex on the concavity of the curves is wide and dense, typical of the third stage of complete healing. The occurrence in two patients of fragmentation of the diaphyseal extremities and of the inner borders of the epiphyseal centers is also shown.

of the knee joint. The child later did not develop tuberculous arthritis and the fragmentation persisted during the entire time of observation (Fig. 9).

The flat bones show changes which do not readily lend themselves to a division into definite stages of disease development and repair. In this series the scapula and the ilium were affected more often in the severe cases of both types. The bones present, in the fully developed stage, a streaked appearance, with marked loss of calcium. This was noted in the scapulae very often in cases which had marked deformities of the chest. One severe case showed cystic areas along the borders of the

Fig. 10. Note the rarefied, cystic areas along the lower inner border of the scapula, due to advanced rachitic change.

scapula (Fig. 10). During the stage of repair, surrounding osteoid zones appear and finally become dense and eburnated just as in the long bones.

The tarsal and carpal bones show changes similar to those found in the epiphyseal centers. In the early stage of the disease they may assume a moth-eaten appearance with a loss of the surrounding zone of temporary calcification. In the second or healing stage the zone of temporary calcification reappears, and an osteoid zone similar to that in the epiphyseal centers is often found. This gradually assumes the appearance of normal bone, depending on the rate of healing.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis between rickets, infantile scurvy, congenital syphilis and the bone changes in acute leucemia have been discussed in a previous communication.[15] Further observation tends to confirm the belief that in cases of combined rickets and infantile scurvy the presence of the intact ring about the epiphyseal centers with a wavy and hazy, indistinct zone of temporary calcification at the end of the diaphysis, is a most trustworthy sign of the presence of infantile scurvy in combination with rickets. Occasionally a framework marrow zone due to the scorbutus may also show in a prominent fashion. As the scurvy heals the ring tends to become increasingly more prominent and wider.

In chondrodystrophia foetalis, Lovett[11] states that the epiphyseal center is constant in maintaining its clearness and regularity of outline throughout the affection, and even though the ends of the diaphysis are broadened, the changes occurring in the areas of endochondral growth in rickets make the differentiation clear from chondrodystrophic deformities which present comparatively uniform densities on the roentgenogram.

In osteogenesis imperfecta congenita (Schinz[17]) the peculiar gnarled and stunted diaphyses with multiple fractures, most often occurring in the new-born infant or in infants of several months of age, present a roentgen picture that is unmistakable. One case of the *tarda* form (Schinz) which has been under observation at the Children's Hospital for two years has shown throughout the long bones a uniform degree of extreme atrophy with no characteristic signs except for occasional transverse striations. This atrophy does not resemble rickets in any way or form.

Osteomalacia. According to Looser (Schinz[17]), osteomalacia is adult rickets, and cases of late rickets which are not healed by the twentieth year progress into cases of adult osteomalacia. If this is true there is no necessity for any attempted differentiation from infantile rickets. However, Blank and Graves[1] have lately reported cases of postinfantile rickets occurring in children from three to six years of age. They conclude that rickets is by no means uncommon in early childhood after the age of three years and before adolescence, and that the existence of bone defects characteristic of osteomalacia in children ranging from three and a half to six years of age tends to prove that osteomalacia is a disease of childhood as well as of later age periods. Their observations suggest that there may be no dividing line between the two conditions. Their diagnosis of osteomalacia in the reported cases was based upon rarefaction in the diaphyses of the long bones which had progressed to a stage too advanced to be explained by infantile rickets of the ordinary type. Jones and Lovett[10] believe that true idiopathic osteomalacia in a serious form occurs in children and is distinct from rickets in the absence of epiphyseal changes characteristic of the latter disease. Hutchison and Stapleton[9] saw no justification for the separation between rickets and osteomalacia and stated that the conditions are the same and represent rickets at different ages. Blank and Graves base their diagnosis of osteomalacia on a cystic appearance of the diaphysis in the roentgenogram, due to a replacement

of the bony tissue within the medullary spaces by soft and friable osteoid tissue lacking in lime salts. They admit that the existence of osteomalacia in childhood has been questioned, and its occurrence, if it does occur in children, must be rare. None of the cases studied in this series seemed to present a picture of osteomalacia such as occurred in those reported by Blank and Graves.

SUMMARY

The roentgen changes in infantile rickets as shown in the long bones can be divided into two main types, the first showing no cupping of the diaphyseal ends, the second showing cupping as the distinguishing characteristic. The cupping can be explained on a mechanical basis. The first type is further subdivided into mild and more severe roentgen manifestations. The second type is the more usual form.

Roentgen signs are lacking in a certain number of cases early in the disease and the diagnosis must be made on clinical signs. A Harrison's groove, a mild rachitic rosary, and laxity and lateral mobility of the knee joints are clinical signs that are frequently present, while no roentgen evidence can be found when the patient is examined.

Serial roentgenograms are very useful and are absolutely necessary to check the effect on healing of any one particular therapeutic agent. If the recognition of a specific therapeutic effect is desired, no case should be used which on its first examination shows the formation of the new zone of temporary calcification.

A classification of these two types into stages showing the roentgen sequence of the disease process is useful for such observation and also for the determination of the proper time for operative intervention, as has been stressed by Lovett.

Fragmentation of the inner borders of the lower epiphyseal center of the femur and of the lower, inner border of the diaphysis of the femur, and of the upper epiphyseal center and the upper and lower inner borders of the diaphysis of the tibia, occurred with sufficient frequency in the cases studied, to suggest that this is an end-result of the rachitic process.

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DISCUSSION

Dr. E. C. Vogt, Boston. Dr. Bromer's paper was so complete that I have nothing to add in the way of roentgen diagnosis of uncomplicated rickets. However, I have been asked not infrequently what sort of picture we get when rickets and scurvy are both present in the same patient. In my experience it is very uncommon to find the two combined. I do not see how they can develop simultaneously for scurvy causes an arrest of bone growth and rickets develops only in growing bone.

The chief characteristics of active scurvy as seen on the roentgenogram are: a narrow dense line at the ends of the diaphyses, lipping of the margins and a zone of diminished density just proximal. The cortices are described as ground glass in appearance. The epiphyseal line is not increased in width but the epiphyseal centers are halo-like due to a dense zone around the margins.

The picture of active rickets is just the opposite. The ends of the diaphyses are indistinct and the epiphyseal line appears to be increased in width due to the growth of osteoid tissue which does not contain calcium. The epiphyseal centers are faintly outlined in counter-distinction to the dense line around the periphery seen in scurvy. The bones in general are poor in calcium and the trabeculations stand out prominently.

Consider then the result, if we superimposed the picture of scurvy over that of rickets. It is almost like imposing black on white or vice versa.

It is my opinion that a patient with rickets does occasionally later develop scurvy, although in my experience this is a very unusual occurrence and with the development of scurvy the rickets tends to heal.

Dr. Bromer (closing). The combination of scurvy and rickets, as Dr. Vogt mentioned, certainly occurs. I am not prepared to say how frequently it is found. I feel that the presence of an intact ring shadow about the epiphyseal center when combined with the evidence of rickets in the shaft, means that the patient has scurvy, coincident with the rickets. What Dr. Vogt has said is perfectly true. In scurvy, a decreased blood supply is found in the diaphyseal ends, the endochondral areas, and on the other hand in rickets there is an increased vascularization in the same areas. Which is going to predominate? While the changes in the epiphyseal center and the endochondral areas in the shaft are analogous, yet I think they do not proceed, as I attempted to show, at the same rate. Why this occurs, I cannot explain. It is possible that in the epiphyseal center, especially in the healing stages of scurvy, there is more chance for the scorbutic process to predominate and to obliterate the rachitic process.

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SOME OF THE DEFORMING BONE DISEASES OF ADOLESCENCE*

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I SHALL not attempt to deal with the well-known systemic dyscrasias resulting in general bone involvement but shall confine my subject to a few of those disturbances that manifest themselves in more or less localized areas. I have grouped them because there is a certain similarity in that they occur usually in the latter half of the first decade and in the second decade of life, their etiology and pathology are obscure and, while they are usually referred to as inflammatory conditions, no definite organism has been isolated, and they finally manifest themselves chiefly as nutritional disturbances resulting in more or less disabling anatomical deformities.

Unfortunately, I think, practically all of them are called by the names of those who were first to report them, which conveys no impression of the existing anatomical or pathological conditions.

1. One of the most recent of these maladies to be recognized as an entity is an osteochondritis of the bodies of the vertebrae, which has been described by Scheuermann,[7] Calvé,[3] and others. This condition, known as Calvé's disease, occurs in children in the first decade and manifests itself in a flattening of the vertebral bodies in their vertical dimension often resulting in the center of the bodies becoming wedge-shaped and a condition of "round back," or if the involvement is confined to one or two of the vertebrae, a distinct kyphosis may be present. Concerning the nature of this and allied conditions several articles by Buchman[1,2] have recently been published. He differentiates this from epiphysitis, but thinks that the latter is a later stage of the same general condition. In vertebral epiphysitis, usually called Scheuermann's disease, which does not appear until after about the twelfth year, when the epiphyses begin to ossify, the epiphyses show irregular development, which gives to the articular surfaces of the bodies a scooped-out or notched appearance quite characteristic in the roentgenogram (Fig. 1). This condition has probably been frequently overlooked, but its presence will doubtless account for many cases of spinal deformity that have been attributed to tuberculous lesions, achondroplasia or compression fractures. It is probable that the flattening and wedge-shaped formation seen in one or more vertebral bodies and attributed to achondroplasia, in the absence of other manifestations of achondro-

FIG. 1. Vertebral epiphysitis (Scheuermann's disease). Lateral view.

* Read at the Thirtieth Annual Meeting, American Roentgen Ray Society, New York City, Sept. 17–20, 1929.

plastic development, have been due in reality to vertebral osteochondritis.

The diagnosis of Calvé's disease or of Scheuermann's disease from tuberculous spondylitis can usually be made by the absence in the former of foci of bone destruction within the ossified nucleus or of a progressive surface erosion with obliteration of the joint space and collapse of the adjacent vertebrae, or of a paravertebral thickening so common in the well-established case or the destruction of the intervertebral disc in tuberculous disease of the cartilage, and especially the absence of positive bovine tuberculin reactions. The differentiation between the deformity due to compression fracture may, when the compression is slight, be quite difficult, but the history of the trauma, the patient's previous condition, the condensation of the cancellous bone usually seen in compression, the lateral spreading and a jagged irregularity of the articular surface in fracture as compared with the smooth notched surface seen in epiphysitis will usually serve to establish a diagnosis.

FIG. 2. Slipping epiphysis—acquired coxa vara.

FIG. 3. Slipping epiphysis, unrecognized and not treated. Note condition of coxa vara.

2. Separation of the head epiphysis of the femur[4] or "slipping epiphysis" is thought to be due to a subacute or chronic epiphysitis, though many authorities claim it is due to unrecognized trauma alone. The condition usually occurs in the first half of the second decade and is found especially in the too rapidly growing child who has a tendency to obesity. It develops gradually and is to be definitely distinguished from an immediate traumatic epiphyseal separation. The earliest appearance is a slight broadening of the epiphyseal line due to lime salt absorption. There may also be a slight clouding of the epiphyseal line (Figs. 2 and 3). It is exceedingly difficult to recognize the condition in this stage and it can be done only by comparison with the normal.

3. Ostéochondritis deformans juvenilis coxae, usually called Legg's disease, Perthes' disease or Legg-Perthes' disease, occurs in rapidly growing children without definite history of injury or infection, es-

Fig. 4. Legg-Perthes' disease—common type. (Courtesy of Dr. V. W. Archer.)

pecially in males between seven and twelve years of age. The condition is recognized by roentgen examination only, after deformity begins or when there is a fairly well-marked decalcification of the head epiphysis of the femur. The head epiphysis appears flattened on its upper aspect as if pressure had been made upon a mass of dough; the neck may be broadened and a coxa vara may result. The contour of the

Fig. 6. Legg-Perthes' disease—fragmenting type. (Courtesy of Dr. V. W. Archer.)

epiphysis is usually smooth though often the epiphysis is divided. When this occurs it may be difficult to differentiate between Legg-Perthes' disease and a tuberculous epiphysitis. In the former condition, however, the joint space does not present clouding and there is no material narrowing of the interval between the bony factors

Fig. 5. Legg-Perthes' disease—common type. Case progressed to marked deformity. (Courtesy of Dr. V. W. Archer.)

Fig. 7. Legg-Perthes' disease—bilateral fragmenting type. (Courtesy of Dr. V. W. Archer.)

Fig. 8. Legg-Perthes' disease showing apparent independent acetabular involvement. (Courtesy of Dr. V. W. Archer.)

composing the joint, differing in this respect from the tuberculous hip. If the acetabulum presents any change at all, it usually occurs late and is generally explained as the result of mechanical distortion from pressure of the deformed femoral head (Figs. 4, 5, 6, 7 and 10).

There are, however, some who hold the opinion that there is sometimes an involvement of the acetabulum that cannot be explained as a secondary result of the deformity in the femoral head. They consider the condition a primary or concomitant involvement due to the same indefinite causes and classify it also as Legg-Perthes' disease.

Fig. 9. Acetabular softening with no involvement of femoral head. No other evidence of hip disease. Is this acetabular Legg-Perthes' disease?

Fig. 10. Legg-Perthes' disease, unrecognized and not treated.

In my own experience I have occasionally seen a softening and broadening of the acetabulum that did not present the usual evidences of atrophic arthritis and I am inclined to believe that a condition similar to that in the head epiphysis of Legg-Perthes' disease does sometimes occur (Figs. 8 and 9). Whether it is identical in etiology and pathology remains yet to be determined.

In order to obtain authoritative opinion in regard to the existence of such an entity, I sent out the following letter to seventeen of the leading orthopedists of America:

> It has been my observation and that of others with whom I have conferred that there is a condition of the acetabulum with or without involvement of the femoral head that is very similar to, if not identical with, the conditions found in the head of the femur in Legg-Perthes' disease.
>
> I shall greatly appreciate it if you will give me your views on this subject and if you know of any proof of the identity of these conditions, I shall be especially glad to have it.

I received replies from fifteen. Of these, seven stated that they had never seen acetabular involvement existing in such

form as to cause the impression that it was independent of the distortion of the femoral head, while five asserted their belief in the occurrence of an acetabular softening similar to that seen in the head of the femur and not dependent upon the action of the malformed head. Three of the replies were unsatisfactory in that no definite opinion was given.

Quoting from the replies received: Dr. Royal Whitman, New York: "I think there is a limited necrosis of the epiphysis of the head and that later changes in the acetabulum are in great part due to the incongruity of the joint caused by the deformity. It seems doubtful if the primary changes in the acetabulum are due to the same cause as those in the head, namely, disturbance of the blood supply."

Dr. Willis C. Campbell, Memphis: "I fully agree with you regarding the changes in the acetabulum with and without Legg-Perthes' disease. There is no reason whatever to assume that the same condition cannot work in the acetabulum."

Dr. Russel A. Hibbs, New York: "I am not familiar with any condition of the acetabulum such as occurs in Legg's disease."

Dr. Frederick C. Kidner, Detroit: "I have several times noticed the acetabulum change which you mention. It has puzzled me profoundly but I have rather come to the conclusion that it is a condition similar to Legg-Perthes' disease, Köhler's disease of the scaphoid, etc. . . . . have operated on two cases on the diagnosis of osteomyelitis. In the first case . . . . I found a staphylococcus osteomyelitis which gradually healed up. In the second case, I found merely abnormal cartilage, apparently degenerated in character, and softened, but not infected bone."

Dr. E. W. Ryerson, Chicago: "In several cases of Legg-Perthes' disease I have seen a corresponding involvement but none that I can recall presented the lesion in the acetabulum alone."

Dr. Albert H. Freiberg, Cincinnati: "I do not recollect ever seeing any condition in which a primary change existed in the acetabulum which I felt must be placed in this particular category."

Dr. M. Hoke, Atlanta: "I don't think I remember ever having seen the acetabulum involved without the head of the femur being involved. This might be possible, of course, but I am simply giving you my impression."

Fig. 11. Tuberculous coxitis showing "kissing sequestra" of Phemister.

Dr. Fred H. Albee, New York: "I have seen, I am sure, x-ray pathology of the acetabulum such as you speak of. I believe it to be similar to Perthes' disease."

Dr. Wm. S. Baer, Baltimore: "I do not know of any authentic cases of Legg-Perthes' disease beginning in the acetabulum."

Dr. Allen F. Voshell, University, Va.: "For some time I have felt that there was a condition in the acetabulum very similar to Perthes' disease. This condition, I believe, may be primary in the acetabulum and secondary in the head of the femur or vice versa and, we have had one or two cases which seem to indicate a primary involvement of the acetabulum."

Dr. D. B. Phemister, Chicago, in his reply gives me unclaimed credit in his statement that he was interested to learn that I had seen Legg-Perthes' disease in the acetabulum. He writes, "I have not seen it but I have seen tuberculosis of the hip with what I describe as 'kissing sequestra,' in which case opposing areas of necrosis developed in the head and acetabulum" (Fig. 11). Dr. Phemister's reply causes the inference that he believes that if acetabular

softening is present the case is more probably one of tuberculosis than a disturbance of circulation due to the same cause that gives us coxa plana.

DR. WILLIAM TATE GRAHAM, Richmond: "I for some time held to the view that the condition did not exist in the acetabulum either independent of the head or as a result of deformity in the head; but I have had good reason to believe that cases have come under our observation where this condition was distinctly present in the acetabulum even where the head was not involved."

While my efforts have brought neither positive nor negative proof I trust that they may arouse some interest in the subject which may lead to more definite conclusions in the future.

Smith[8] has reported a case presenting the appearance in the roentgenogram of a condition of the left capitellum similar to that found in the same patient who showed a typical osteochondritis deformans juvenilis in the left hip.

Lewin[5] reports a case of osteochondritis juvenilis in the head of the humerus in a child four years of age.

4. Apophysitis of the anterior tibial tubercle, or Osgood-Schlatter's disease, usually occurs in boys who are active in athletic exercises especially running and jumping and is usually attributed to trauma. My own belief is that it is most probably preceded by an infectious apophysitis, and the separation that is usually present is the result of added trauma which may be either slight and frequently repeated or a single injury of greater severity. The apophysis is tender and the tissues overlying it are swollen. Roentgen examination shows considerable bone irregularity appearing either as irregular ossification or a separation of at least a portion of the tubercle (Fig. 12). The symptoms usually subside as the tubercle develops, leaving it enlarged. In some instances recovery is greatly prolonged.

Fig. 12. Tibial apophysitis (Osgood-Schlatter's disease).

FIG. 13. Köhler's disease.

5. Osteochondritis of the tarsal scaphoid, usually called Köhler's disease, manifests itself as an abnormal development of the nucleus of the tarsal scaphoid resulting in flattening from before backward. The roentgen appearances are mottling, flattening of the nucleus, irregular and delayed development (Fig. 13). A more recently described deformity involving the head of the second metatarsal is probably an allied condition and since it also has been described by Köhler it has been known as Köhler's second disease.

I have omitted osteochondritis dissecans, Preiser's disease of the carpal scaphoid, Kienböck's disease of the semilunar and Kümmell's disease of the spine, all of which seem to be manifestations of the same general condition of disturbed blood supply resulting from trauma. These are usually seen after the second decade and do not

rightfully belong to my subject. It is probable, however, that osteochondritis dissecans begins during adolescence, but is usually not discovered until adult life.

I should like to report a case of absorption of the bones of the forearm which occurred in a child and which seems to support Axhausen's theory of atrophy of bone resulting from traumatic disturbance of the blood supply.

M. V. H., white, female, aged three, fell July 2, 1922, while running, fracturing both bones of the forearm at the junction of the middle and distal thirds. The fractures were "set" and the forearm put up in splints. When the dressing was removed the position and alignment were found to be unsatisfactory and a corrective operation was performed September 13, 1922, freshening the surfaces and fastening them in position with chromic gut. Seven months later a roentgenogram showed atrophy of both distal fragments manifesting itself in a general shrinking of the whole of both. This shrinkage continued until there was a complete disappearance of the distal fragment of the ulna, and almost total absorption of the lower end of the radius. A small triangular portion of the radius remained at the carpal end. A brace was applied and the case was watched, films being made at lengthening intervals, up to May 29, 1929.

Fig. 14. Case of M. V. H. Traumatic postoperative absorption of the radius and ulna. Film six years after operation, showing considerable regeneration of the radius. Films made in the interim were not preserved.

Fig. 15. Same case as shown in Figure 14 one year later.

There has been an irregular growth of the bones above the fracture sites and the child seems well nourished and in perfect health. There was only slight restoration of the radius up to July, 1927, but a film made in August, 1928, showed a very marked regeneration of the radius (Fig. 14), which has continued up to the time of the last examination (Fig. 15). There has been no visible restoration of the lower end of the ulna except a small irregular line of ossification extending downward from the fracture site.

An interesting point in the case is the fact that while under observation she fell again producing a "green stick" fracture of the upper fragment of the radius. This promptly healed by bony union leaving only a slight irregularity to mark the location of this fracture.

The only explanation I have been able to elicit is that there was an injury to the blood vessels supplying the distal fragments, which resulted in absorption according to Axhausen's idea.

Treatment. The essential factor in the treatment of all these deforming lesions of

adolescence is to relieve the stress until well after the acute processes have subsided and regeneration of bone has proceeded to an extent sufficient to withstand the weight or strain upon the involved area, thereby so far as possible preventing deformity.

To this end, rest in bed, suitable dietary and other measures to promote healthy metabolism are especially indicated. When there are evidences of subsidence, as relief of pain, return of the temperature to normal if, as often occurs, there has been an elevation, suitable appliances may be used to enable the patient to become ambulatory, and a gradual return to weight bearing or stress permitted, observing clinically and roentgenologically the effects of the strain upon the diseased member. These measures are, of necessity, long drawn out and require much patience and endurance, but a matter of a few months or perhaps a year or more devoted to the prevention of deformity or restoration to normal is of little consequence when compared to a life long disability.

SUMMARY

It seems that in all the foregoing conditions the immediate cause of the deformity resulting from the bone changes is deficient blood supply which may be caused by traumatism, infection involving the blood supply and, perhaps usually both of these factors in a greater or less degree. Osteochondritis or epiphysitis may involve the adolescent bone in any locality but is most frequent in those localities where greater stress is borne.*

* I wish to acknowledge my indebtedness to the well-known orthopedists from whose letters I have quoted and to Drs. F. M. Hodges, William T. Graham, A. F. Voshell and V. W. Archer for the use of films of several of their cases.

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DISCUSSION

DR. HENRY K. PANCOAST, Philadelphia. It is unfortunate that there are a large number of conditions known by various individuals' names such as Freiberg's so-called infraction, which it is not, Köhler's disease, apophysitis of the os calcis, Osgood-Sclatter's disease, Legg-Perthes' disease, and so on, all of which are probably more or less alike in their pathology, and in which we have to use the names of many of the individuals in designation of them. Euphony requires this because the technical names of the conditions are almost too long for use.

There are two similar conditions in the spine which belong to two different age periods and for that reason I believe it is very much wiser to use technical names. Another reason is that it is difficult to remember which name belongs to which condition. Calvé's disease which is the first one to occur, involves the early central epiphyseal centers of the bodies, corresponding to the diaphyses of the long bones. Scheuermann's disease is the second one to occur and in the subsequent period of development. We might very well apply, as has already been suggested in the literature on

one occasion, the term osteochondritis vertebrae, indicating the first one juvenilis and the second one adolescens. These terms are much easier to remember as far as I am concerned than Calvé's and Scheuermann's diseases.

In the adolescent type, or Scheuermann's disease, the resulting deformity in the edges of the vertebral bodies may persist for some time in later life and may be mistaken for fractures or body crushes. We can usually get a history of some previous deformity of the spine or some disability of childhood to help us in our diagnosis. In Scheuermann's disease the vertebral discs are preserved, whereas they are not preserved in a tuberculous disease of the spine.

In Calvé's disease one should not be too hasty in making a diagnosis in very young individuals for the reason that the epiphyseal development of the vertebral body itself may to a certain extent resemble the deformity of this disease. Our attention has recently been called to the fact that the persistence of blood vessel channels in the anterior portions of the bodies of the vertebrae may also resemble the appearance of Calvé's disease.

In connection with the slipping of the epiphysis of the femoral head, it will usually be found in these cases that there is a history of slight trauma, and that this slight trauma is very often preceded by a history of certain disability or pain or a limp, so that we probably have both factors concerned in the slipping, and in aggravated cases I have seen a complete epiphyseal separation occur with very little trauma, certainly insufficient for a separation to occur in a normal child.

THE ROENTGEN DEMONSTRATION OF CALCIFIED FILARIA BANCROFTI IN HUMAN TISSUES*

By F. W. O'CONNOR, M.R.C.S., ROSS GOLDEN, M.D., and HUGH AUCHINCLOSS, M.D.
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INTRODUCTION

IN MANY tropical countries where the nematode worm, *Filaria bancrofti*, is indigenous amongst the native population, the term "filariasis" is used to include a variety of clinical conditions which are believed by many workers to be attributable to the presence of the worm. The adult parasite in the human host lives in the lymphatic vessels and glands or in the connective tissues. It manifests its existence either by the presence in the blood stream of embryo worms named microfilariae, or by certain clinical phenomena.

The transmission of the infection from man to man is by means of a mosquito, the species varying according to country. When the insect sucks blood from a person harboring microfilariae the parasites, on reaching the stomach, shed their enveloping sheath and find their way to the thoracic muscles of the mosquito host. In this situation they lie between the muscle fibers and undergo considerable development. After a period varying according to climate but generally less than twenty-one days, the parasites migrate to the head and later to the proboscis of the insect. If then the mosquito bites another person the parasites find their way to the skin which they penetrate independently of the wound made by the insect.

The usual manifestations of filariasis are lymphangitis, lymphadenitis, chronically enlarged and varicose glands and lymphatics, hydrocele and chyluria. In filarial countries, lymphadenitis and lymphangitis have been noted in visitors within six months after their arrival and there is good reason for believing that such symptoms are early indications of filarial infection.

The attacks of lymphangitis, though sometimes mild, may be very severe and are then accompanied by chills, fever and sweating. With the onset of the fever there is frequently vomiting and severe headache and sometimes delirium. Locally, the affected area becomes very painful, tender, red and swollen. The attacks usually last about a week and in some persons have a tendency to recur with regularity once a month or more frequently. In many cases following a number of attacks, elephantiasis develops and this causes very embarrassing disfigurement. Sooner or later the frequent recurrences of lymphangitis, especially if associated with elephantiasis, may partly or completely incapacitate the patient for work.

If the most severe pain and inflammation during the febrile period occur in the superficial glandular areas and if the glands themselves during the afebrile periods are enlarged and palpable, experience has shown that there are worms in these or the adjacent tissues. In a large proportion of cases, however, symptoms suggest that the worm is in a distal portion of the affected limb or appendage. Recently[7,8,9] emphasis has been laid on the presence of a small spot or area in which pain is either the primary symptom at the onset or is most intense during the inflammatory phase of attacks of lymphangitis or elephantoid fever believed to be filarial. Sometimes during the afebrile periods, without visible signs of local swelling or pain, slight tenderness on pressure may be present in such areas.

The association of these areas with the presence of a living or recently dead filarial worm has recently[10] been con-

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firmed by finding the adult worm or worms in sections of subcutaneous tissue from a number of such "focal spots" in patients suffering from lymphangitis in Porto Rico. It is of interest that after the removal of these focal spots the patients' symptoms have disappeared and there have been no recurrences in a follow-up period of more than a year. It is, however, often difficult to localize the actual site of the worm in such cases as the physician has only the history of the patient and, very rarely, between attacks some local tenderness to assist him. In the majority of cases the history has been the only guide.

Pathological studies by Bancroft,[2] Lewis,[3] Maitland,[5] Young,[11] Lothrop and Pratt,[4] Manson Bahr,[6] and others, have shown that in certain situations, e.g., groin or epitrochlear glands, filarial worms may be present in large numbers, both alive and in various stages of calcification. During recent pathologic studies by one of us (F. W. O'C.) this fact has been noted frequently and in one instance fifteen adult worms were found in one group of superficial femoral glands. It was observed in this and many other cases that not only were calcified worms present with living worms but that living or recently dead parasites were frequently found in the *immediate vicinity* of calcified worms. This relationship seemed to indicate that it could not be accidental and to suggest that the finding of calcified worms in less accessible situations might lead to the discovery of living worms. Christopherson[1] has suggested the use of the roentgen ray for the detection of calcified filariae and described a case, complicated, however, by calcification of the anterior tibial blood vessels. He mentioned "cyst-like" shadows in the roentgenograms suggestive of filariae. These findings were not confirmed by microscopic studies of the tissues.

STUDIES WITH PATHOLOGICAL MATERIAL

As a preliminary to the present studies with living tissues it was deemed advisable to make roentgenograms of gross pathological material known to contain adult filariae, of which the following is an example.

Case S. A Porto Rican male, aged forty, was murdered and a necropsy performed within a few hours. Hydroceles were found on both sides. The fluid in the right hydrocele contained large numbers of microfilariae. The testicle, hydrocele and spermatic cord on this side were removed. On examining the cord three hard nodules were felt. These were removed and on section seven adult filariae were found. Three of these were calcified and immediately adjacent to them were two re-

Fig. 1. Roentgenogram of the testicle and spermatic cord removed at necropsy discloses numerous shadows of calcium density, some of which are indicated by the arrows. The pieces of tissue indicated by the upper two arrows upon section were found to contain several adult filariae, some of them calcified (Figs. 2 and 3).

FIG. 2. Photomicrograph (×125). Section of the tissue indicated by the topmost arrow in Figure 1 disclosed completely calcified segments of a worm. The arrows point to partially calcified segments of a female, in the uterus of which many degenerated microfilariae can be seen.

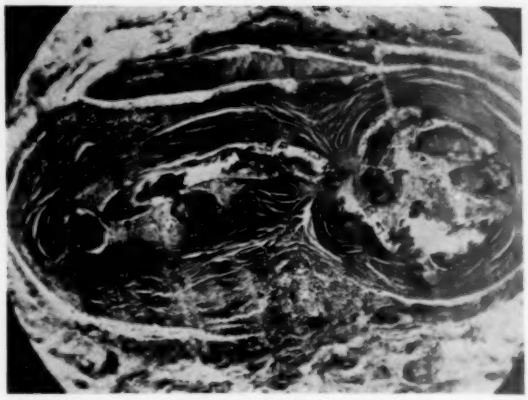

FIG. 3. Photomicrograph (×125). Section of the tissue indicated by the next-to-the-top arrow in Figure 1 discloses segments of a calcified filaria surrounded by a dense fibrous capsule.

cently living worms. One of the living worms was a male and the other an immature female.

A roentgenogram of this specimen (Fig. 1) was made on a plain film. Scattered throughout its shadow are small, elongated, ovoid areas of calcium density which range in size from about 1 mm. in width and 2–3 mm. in length to tiny dots. In some places they are single; in others they are arranged in chains of two or more.

Two small pieces of tissue containing the shadows indicated by the two upper arrows in Figure 1 were excised and sectioned. Calcified worms were found in both. In Figure 2 is shown a section from the tissue indicated by the topmost arrow containing a partially calcified female worm in which the lobes of the uterus enclosing microfilariae can be made out. Figure 3 shows sections of a calcified filaria from the tissue marked by the next-to-the-top arrow in Figure 1.

CLINICAL STUDIES

In view of these roentgenographic findings it was decided to study clinical cases by this method.

CASE E. G. (Unit No. 215002). A white, unmarried seamstress, aged thirty, was born in Georgetown, Demerara, where she lived until the age of eighteen when she came to New York. Her grandmother and one aunt have filariasis of both legs. One brother has a persistently swollen hand with no history of attacks of lymphangitis.

At the age of nine the patient had severe pain in the left groin which became swollen and red. The same evening she experienced severe pain in the following regions on the same side: back of calf 6 inches above ankle; base of the middle toe where a lump developed; on the inside of the instep; sole of foot under the arch; 3 to 4 inches above the knee on the inner side of the thigh at the upper margin of the redness and swelling. In later attacks this was the area of most severe pain.

After the onset of these pains she had a chill followed for three days by high temperature accompanied by headache and nausea but without vomiting. The leg became swollen and red up to the lower part of the thigh. The redness lasted one week. The fever ended with sweating.

The second attack, involving the right leg, came when the patient was thirteen years old. It began with "gripping" pain at the back of the calf without pain in the groin. Lumps developed on the outer side of the leg 4 inches above the external malleolus and also one inch below the internal malleolus. A chill and fever (103°F.) occurred as in the first attack and the duration of the fever and the redness were the same.

A year later the patient had an attack in the left leg similar to the first, except that there was no pain or swelling in the groin. Since then she has had an attack every year, usually in July or August, in one leg or the other but never in both legs simultaneously. The legs remained slightly swollen after the first and have become increasingly larger with subsequent attacks. There have been three or four since her arrival in New York. The last, in September, 1923, involved the left leg and was especially severe.

The physical examination disclosed nothing abnormal except considerable enlargement of both legs, more marked on the left. The swelling was of the edematous type. No trophic changes were observed in the skin. There were deep sulci between the bases of toes and the dorsum of the foot on both sides. Tender areas were present on the internal aspect of the tibia, 3 inches above the ankle on the left and a little higher on the right leg in front. On the inner side of the left thigh was a tender spot about 3-1/2 to 4 inches above the condyle of the femur. No redness was noticed and no thickening or swelling was felt in the skin. There was nothing to indicate the possible position of a worm except the patient's statement regarding localized pain and the above-described tender spots.

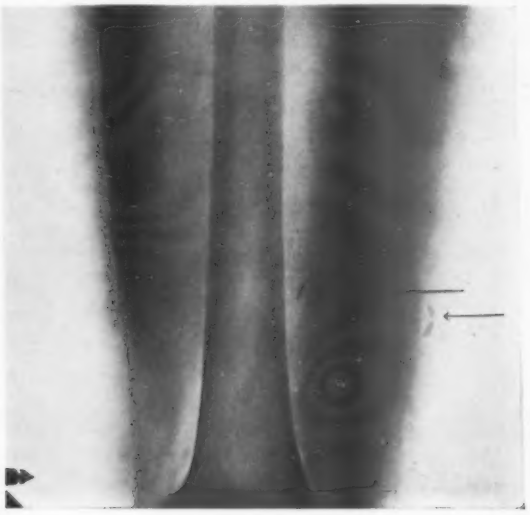

Fig. 4. Roentgenogram of the lower part of the thigh of Case E. G. discloses two small shadows of calcium density in the subcutaneous tissue and one in the region of Hunter's canal.

The blood examination showed: red blood cells, 5,890,000; white blood cells, 10,320; Hgb(Sahli), 98 per cent. Differential count: polymorphonuclears, 62 per cent; lymphocytes, 38 per cent; eosinophiles, 0; large mononuclears, 0. No microfilariae were found in 20 cmm. of blood taken at midnight. The stool examination disclosed no protozoa or helminthic ova. The urine was negative.

Roentgenograms of the left thigh and leg in anteroposterior and lateral positions (Fig. 4) disclosed two small elongated shadows of calcium density, about 1 by 3 or 4 mm., lying in the subcutaneous tissue outside the muscle about 10 cm. above the knee on the medial aspect. A third shadow of similar size and character lies near the femur at the same level in approximately the region of Hunter's canal which is a favorite resting place for adult filariae. The position of these shadows in the subcutaneous tissues corresponded with the

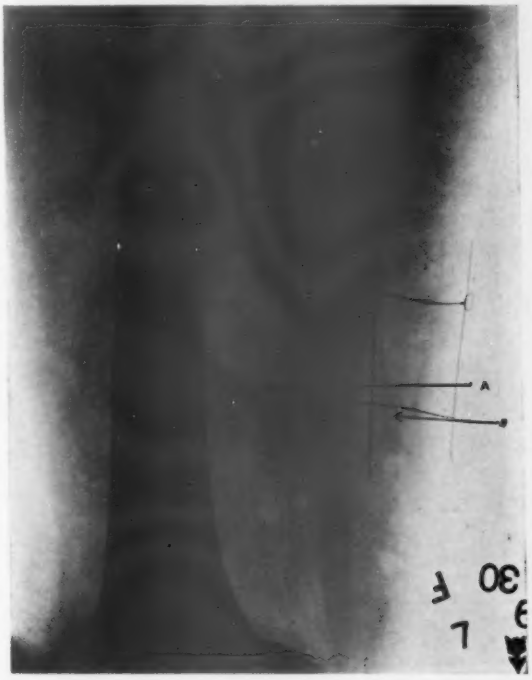

Fig. 5. Method of localizing the shadows in the subcutaneous tissue indicated by arrow B. Hyponeedle wires were fastened to the skin by collodion in the region where the calcified worms were thought to be and stereoscopic films were made. The shadows lie just below the lower cross wire. Arrow A points to the shadow in the region of Hunter's canal.

site of tenderness on the thigh, described above, and they were interpreted as a calcified filaria.

To localize these shadows for excision, four hypodermic needle wires were placed in a square over the region where the shadows were thought to be and fastened in place with collodion. Stereoscopic roentgenograms were made (Fig. 5) and the position of the shadows with respect to the wires was determined. The position of the wires was marked on the skin with methylene blue for the guidance of the surgeon (Fig. 6).

In addition, a tender area had been located on the anteromedial aspect of each leg as the probable site of a worm although no significant shadows could be detected on the film.

Operation was performed on February 6, 1930. The following procedure was carried out in the three areas indicated in the diagram (Fig. 7). A wide elliptical area of skin, subcutaneous tissue and its corresponding deep fascia, measuring about 15 cm. long and 10 cm. at its greatest width, was excised. In the area on the inner aspect of the left thigh a silk suture was taken in the skin as nearly as possible at the site of the calcified worm localized on the roentgenogram with fine wires as described above. This served as a mark for the subsequent sectioning of the specimen. The skin edges were brought together with fine dermal suture tied over rubber tubes on either side to take up the tension and with a continuous approximating silk suture. Following operation the patient had an uneventful convalescence.

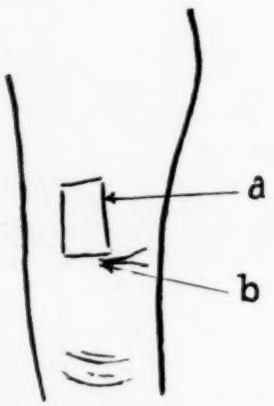

FIG. 6. (*a*) Lines were drawn on the skin at the site of the wires shown in Figure 5. (*b*) At operation a suture was placed in the skin at the level of the shadows as a guide for sectioning.

FIG. 7. Diagram showing the areas excised at operation, Case E. G.

The tissue removed from the left thigh was cut into five large blocks and roentgenograms were made immediately after operation before fixation. In Figure 8 the shadows of the calcified worm in block 2 are clearly seen. A less definite shadow is present in block 4, not seen in the films taken before operation,

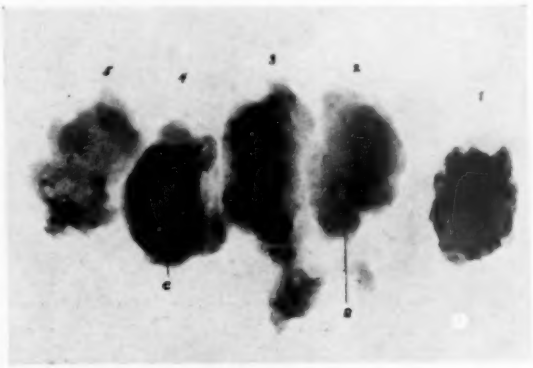

FIG. 8. Roentgenogram of the tissue removed from the inner aspect of the left thigh after cutting into five blocks. Arrow B indicates the shadows in block 2 shown on films made before operation. Arrow C points to a very small dense shadow, not seen on previous films, which was found to be a partially calcified worm.

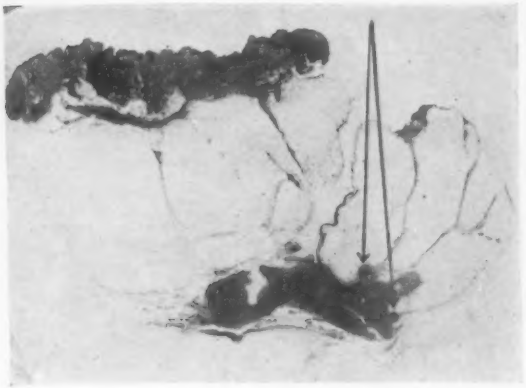

Fig. 9. Photomicrograph (×11) from block 2 at the level of the shadows (B) in Figure 8. Two calcified male worms lie about 1 cm. in subcutaneous fat and apposed to markedly hypertrophied blood vessels.

which was later proved to be a partially calcified worm.

As presented for pathologic examination, the specimens consisted of skin and subcutaneous fat which in places was over an inch in thickness. Both dermis and epidermis appeared normal. In the thick subcutaneous fat were markedly thickened blood vessels. No other abnormality was detected.

Block 2, in which the above-described roentgen shadows were demonstrated, was cut in serial sections and stained with hematoxylin and eosin. In some of the sections two small dark-staining masses (Fig. 9) could be seen with the naked eye which upon microscopic examination proved to be two calcified adult male filariae (Figs. 10 and 11) in the fat about 1 cm. from the surface of the skin. Between the sections of the worm are fibroblasts and large faintly pigmented cells and in places large multinucleated giant cells are present. Immediately surrounding it is a capsule of fibrous tissue about the thickness of the diameter of the worm, arranged in concentric rings. On the inner surface of this capsule there is no evidence of endothelial cells or other structures suggestive of a lymphatic vessel. The worm, therefore, seems to be lying

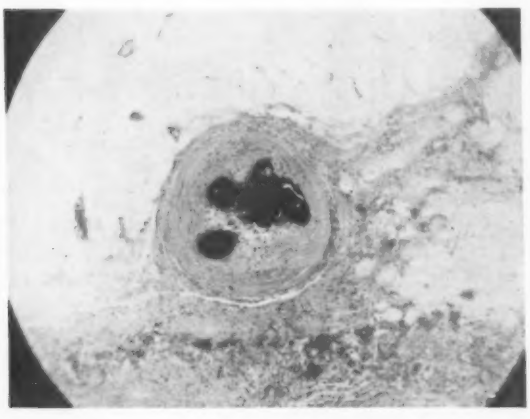

Fig. 10. Photomicrograph (×125). The completely calcified segments of one of the worms shown in low power in Figure 9 are surrounded by a thick fibrous capsule arranged in concentric rings with collections of round cells in its periphery.

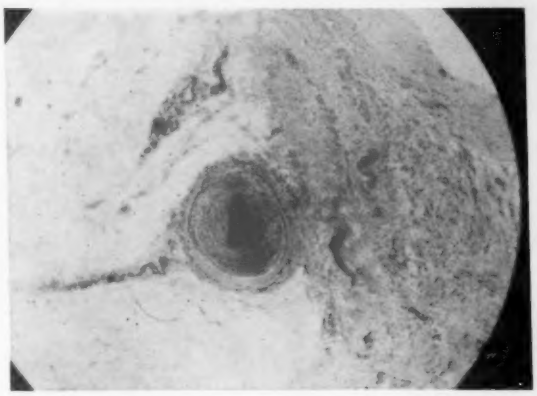

Fig. 11. Photomicrograph (×125). The completely calcified head of the second worm in Figure 9 is surrounded by a thick fibrous capsule.

in connective tissue. Among the fibers of the capsule are elongated cells with long nuclei and adjacent to its outer surface are small deposits of lymphoid tissue and isolated groups of small round cells. Around the fibrous capsule is a loose mesh of connective tissue containing numerous engorged blood vessels. Immediately adjacent to the worm the blood vessels are enormously thickened and in some sections almost occluded. Most of the thickening is in the tunica media. Eosinophilic cells are conspicuously absent. In some of the sections practically no calcification is present and the structure of the worm can be made out clearly.

In the same block but in different locations two other very slightly calcified worms, one a male (Fig. 12), the other a female, were found. The amount of calcium present was apparently not sufficient to produce a roentgen shadow.

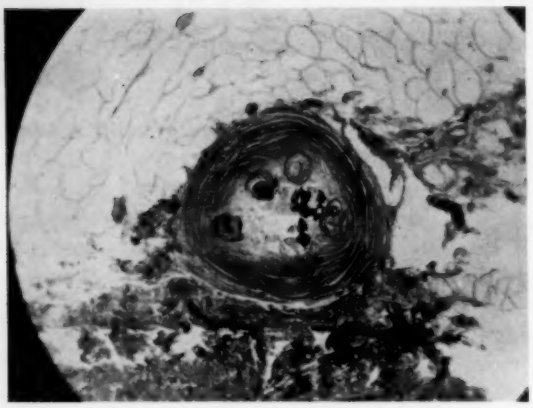

Fig. 12. Photomicrograph (×125). Segments of two worms from another part of block 2 lie within the same fibrous capsule. In the outer wall of one is a very slight calcium deposit. In the other calcification is a little more advanced but is not sufficient to cast a shadow on the roentgenogram.

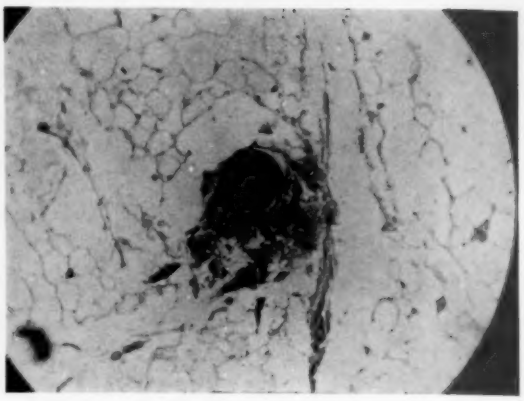

Fig. 13. Photomicrograph (×125). The end of the fibrous tube surrounding a female worm, portions of which were calcified (Fig. 7, shadow c in block 4). The worm itself is not present in this section. The end of the tube is filled by a multinucleated giant cell, by round cells and fibroblasts and by a protuberance of fibrous tissue extending from the inner wall of the capsule.

In block 4 another calcified worm as well as a non-calcified male were discovered (Fig. 13). The tissue changes in the vicinity of these worms were identical with those already described. These parasites lie about 1 cm. from the surface of the skin embedded in fat and apposed to hypertrophied blood vessels.

Blocks 1, 3 and 5 and the material from both lower legs have not as yet been studied microscopically.

Stimulated by the confirmation of the roentgen shadows in this case as calcified filariae, we have made roentgenographic studies of other cases. A forty year old negress, born in Antigua, B. W. I., came in with elephantiasis of the right leg and a typical history of filariasis beginning at the age of twenty-six. Roentgenograms of her right leg and thigh disclosed fifteen separate shadows or groups of shadows similar to those described above. A man of thirty, a native of Dutch Guiana, with a history of filariasis, elephantiasis of the right leg and hydrocele, has two typical chains of shadows in the roentgenogram of the scrotum. A Chinaman of forty-five was admitted because of gonorrheal arthritis of both shoulders and the right foot. Microfilariae were discovered incidentally in a blood smear made in the daytime. He has no history of symptoms suggesting filariasis. A roentgenogram of his scrotum disclosed two small elongated shadows of exactly the same character as those discussed above. Although none of the shadows in these cases have been checked up histologically, there seems to be no reason to think they represent anything other than calcified filariae.

DISCUSSION

It is obvious that the size of the roentgen shadow depends upon the extent of the calcium deposit in the worm. Early calcification visible microscopically may not be distinguishable on the film. In Case E. G. the roentgenogram of the specimen after operation disclosed a shadow in block 4, later proved to be a worm, which was not detected on the films made before operation.

The roentgen shadows in some of these cases are very small and are not easy to detect. A biconvex lens is useful. They are situated among streaky mottled shadows in the subcutaneous fat which, histological examination seems to indicate, are due to markedly hypertrophied blood vessels. The

latter cast very ill-defined, fuzzy shadows while those of the calcified worms are a little more dense, clean cut and sharply defined. To secure the greatest possible detail and to avoid confusion with the tiny spots which are likely to be present with intensifying screens, unless they are brand new, we have used plain films. A fine focus tube and a technique calculated to give soft tissue detail have been employed. Oblique as well as the usual positions in examining the leg are desirable to bring various portions into profile, as the worm shadows lie in the subcutaneous tissue and seem to be easily obliterated by overlying muscle.

An experienced roentgenologist would hardly confuse the shadows of calcified filariae with those of calcified arteries. Small subcutaneous phleboliths, although not common, are occasionally encountered. Their shadows may be very similar to those under discussion; they are likely to be larger, thicker, smoother, more oval and to lie closer to the skin.

The relation of the "focal spots" in the extremities to the patient's symptoms has been pointed out in the introduction. The localization of living worms through their juxtaposition with dead calcified worms is important in the surgical attack on the disease as the recurrence of symptoms may be interrupted and the elephantoid leg improved by excision of living worms.

Many workers have shown that numerous adult filariae may be present within the scrotum and lymph nodes. Our observations show that similar aggregations of worms may be present in small areas in the limbs. It is of interest that in the elephantoid extremities these parasites usually lie between the skin and superficial fascia in an immense fat deposit similar to the masses of fat found in lymph varices in the femoral region and surrounding filarial inguinal and femoral lymph nodes. In this fat marked enlargement and fibrosis of both veins and arteries is present, especially in the vicinity of the worms where these vessels are almost occluded. Hunter's canal, the epididymis and the spermatic cord are also favorite locations for adult filariae.

These studies seem to indicate that the infection may be quite extensive. Since six worms were found in a small subcutaneous area, it is possible that many others might be revealed by a long and careful search. Fifteen shadows or groups of shadows interpreted as calcified worms were detected in one elephantoid leg. These findings are evidence of hyperfilariation which may have an important bearing on the production of elephantiasis.

SUMMARY

1. The histologically proved juxtaposition of dead, calcified and living, non-calcified adult filariae in human tissues suggests the possibility of locating the latter by the roentgen demonstration of the former.

2. Roentgenograms of specimens of skin and of testicle and spermatic cord removed at operation or necropsy from cases of filariasis in Porto Rico and known to contain adult filariae have shown small shadows of calcium density. Two such shadows from a spermatic cord were proved microscopically to be calcified adult worms.

3. Roentgenograms of the elephantoid leg of a patient with a typical history of filariasis disclosed two small shadows of calcium density in the subcutaneous fat, similar in character to those demonstrated in pathological material, which upon histological examination proved to be two calcified adult filariae. Near them were two other worms containing so little calcium that they could not be seen on the film.

4. The roentgen shadows of calcified filariae vary in size from 1 by 4 or 5 mm. to small dots, depending upon the extent of the calcium deposit in the worm. They may appear singly or be arranged in chains.

5. Inasmuch as the excision of "focal spots" containing living worms from an elephantoid leg has been followed by improvement in symptoms, the roentgen demonstration of calcified filariae may aid in localizing the attack on the disease.

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AN APPRAISAL OF THE MOTOR-TEST-MEAL IN THE ROENTGEN EXAMINATION OF THE STOMACH AND SMALL BOWEL*

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THE history of the roentgenologic test of gastric motility began almost contemporaneously with that of the roentgen ray itself. On the suggestion of Bowditch in 1896, only a year after Roentgen's discovery, Cannon employed a meal containing bismuth subnitrate to study the gastric emptying time of various foodstuffs in animals, and thus laid the foundation for his work on the mechanical factors of digestion. In 1898 the Nestor of American roentgenologists, Williams, assisted by Cannon, studied the stomach of human beings in the same way, giving incidental attention to gastric motility. Not until the second decade of this century, however, did the roentgen method of examining the alimentary canal begin to be applied confidently for the purpose of distinguishing between health and disease. Near the beginning of this period Rieder devised his opaque meal which comprised definite quantities of bismuth carbonate and corn-starch-pap. This meal was employed not only to demonstrate the size, general form, position, tone, mobility, peristalsis and contour of the stomach, but also to determine the gastric clearance time. It was taken up by Viennese roentgenologists, a time-limit of six hours was set for normal evacuation, and at the expiration of this period a second meal was given to complete the examination.

Since then the investigation of motility has become an integral feature of the examination as conducted by roentgenologists the world over, although the composition of the test meal and the conditions of its administration have varied rather widely. When the roentgen examination of the digestive tract was adopted at The Mayo Clinic, the test of motility was included as an essential part of the routine. The meal consisted of 2 ounces of bismuth subcarbonate in 4 ounces of thoroughly cooked breakfast cereal, and was permitted to be eaten with a little sugar and milk. It was given to the patient after an overnight fast, usually also immediately after tubage for gastric analysis, and he was forbidden to take other food or drink, except water, during the next six hours. At the end of this period the roentgen examination was made, an aqueous suspension of bismuth being given to depict the stomach and duodenum. Later, barium sulphate was substituted for the bismuth salt, and without any other modification this procedure has been standard at the Clinic for more than fifteen years. In laboratories elsewhere, similar tests are carried out, or the barium is directed to be taken in a mixed meal containing proteins and fats, or the progress of different barium emulsions is traced. Obviously, all comment that I shall offer is grounded primarily on our own procedure.

By experience it has been learned that a gastric residue from this meal, six hours after its ingestion, is due in most cases to one of three diseases: gastric cancer, gastric ulcer or duodenal ulcer. Many years ago in a study of 950 patients examined and operated on at the Clinic it was found that approximately 60 per cent of the gastric cancers in this group, 45 per cent of the gastric ulcers and 28 per cent of the duodenal ulcers were accompanied by gastric retention. Although these statistics probably are still valid as representing the

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order of incidence, all the percentages are doubtless lower at this time, for these diseases are now discovered at an earlier stage than formerly. In cancer the retention is usually a result of obstruction by the tumor, although in ulcerating cancer reflex spasm of the pylorus apparently may be the sole obstructive element. Gastric ulcers situated near the pylorus occasionally produce obstructive retention by cicatricial constriction, but this is relatively uncommon and most retentions from ulcer are attributable to spastic contraction of the pyloric segment, which is a common accompaniment of gastric ulcer, wherever situated. Some unfinished experimental work which I have recently carried on indicates that the path of the reflex is through the vagus. In extreme instances of organic hourglass contraction, whether due to ulcer or cancer, retention may occur in either loculus or in both. Apparently duodenal ulcer produces a gastric residue only by cicatricial stenosis of the duodenal lumen. Although ulcer of the duodenum often gives rise to marked spastic narrowing, this does not seem to be an adequate cause for the production of a gastric residue. It is probable that the spastic stenosis is overcompensated by the hypertonus, hyperperistalsis and patulous pylorus which are common features of duodenal ulcer.

Among the rarer organic causes of obstruction and gastric residues after six hours, are ulcer in the pyloric ring, hypertrophy of the pyloric muscle, congenital pyloric stenosis, adhesions about the duodenum from pericholecystitis, benign tumors of the gastric antrum, especially those which are pedunculated and obstruct the pylorus in the manner of a ball-valve, cancer or ulcer of the upper segment of the jejunum, and gastrojejunal ulcer following gastroenterostomy. It is a peculiarity of gastric syphilis that it so rarely causes retention from the motor-test-meal, yet this occurs in about 6 per cent of the cases.

Not always does gastric retention at six hours signify organic disease of the stomach or upper segment of the small bowel, although the percentage of such residues is small. As chief among these exceptions I would nominate the retention, often considerable in amount, which so frequently accompanies an attack of migraine. The mechanism of its production I do not know, but it has been observed so often that our invariable custom in every instance of a residue is to ask the patient if he experienced severe headache after taking the meal. There is reason also to believe that sometimes retention may result merely from dread of the examination or the disclosures it may bring, or from other profoundly depressive emotions. A residue will commonly be found in patients who are addicted to the habitual use of morphine. Occasionally retention may be encountered in cases of tabes dorsalis without other discoverable cause. Irritation following tubing of the stomach for analysis of the gastric contents not rarely induces considerable hypersecretion, and I am confident that this water-logged condition is sometimes the cause of retention. When the stomach is markedly hypotonic, elongated and pendulous, with its lower pole well down in the pelvis, its evacuation is slowed; whether the delay will ever extend beyond six hours is doubtful, but this possibility must be admitted. Retention may rarely occur in association with cholecystitis or chronic appendicitis; since a spastic condition of the antrum is also observed at times in these diseases, it is assumed that the retention results from a reflex, spastic pylorostenosis. Finally, unless the patient is under continuous control during the six-hour period, he may violate instructions, take additional food, and thus almost certainly retard gastric clearance beyond the time limit. It is noteworthy also that a hospitalized patient is more likely to have a six-hour gastric retention, either from functional or organic causes, than an ambulant patient. As to

the converse, hypermotility, with advancement of the meal far into the colon at the six-hour period, there is little to be said. It is seen in nonobstructive cancer, syphilis and duodenal ulcer, but it often occurs also in less grave conditions and in purely functional states, so that, to use the phrase of W. J. Mayo, it ranks low among the "small change" of diagnostic currency.

If these facts and opinions can be taken as a fair basis it may be profitable to strike off a balance sheet showing the assets and liabilities of the motor-test-meal. On the credit side may be listed the following:

1. A gastric residue at six hours is so strongly indicative of organic disease, either in the stomach or the proximal portion of the small bowel, that the examiner will be stimulated to search carefully for a causative lesion. Often the direct signs of disease can be discovered only by close scrutiny.

2. In combination with other manifestations a residue has directive value. A residue in a small stomach with a spastically narrowed antrum is strongly suggestive of gastric ulcer. Retention in a stomach with an obliterated antrum usually signifies cancer. If the antrum is enlarged but un-deformed, duodenal ulcer is the most likely cause.

3. In the early days of roentgen diagnosis, the residue was accepted as a component of certain sign-complexes. At that time deformities of the luminal shadow were seldom easy to recognize, and the roentgenologist felt obliged to consider all phenomena, whether important or trivial. Lewis Gregory Cole had not yet shown that bulbar deformity was the outstanding sign of duodenal ulcer, and its diagnosis was often based on retention in a stomach of normal contour exhibiting hyperperistalsis. Incidentally, it may be said that this combination is still fairly diagnostic.

4. When the niche, defect or deformity produced by a lesion is so small or indistinct that the examiner is in doubt, the presence of a residue is an item of corroboration.

5. The response to the test of motility may be considered in differential diagnosis. Because of the higher incidence of retention in gastric cancer and gastric ulcer, its presence or absence may have a certain slight weight in deciding between these lesions and syphilis or other disease.

6. The presence or absence of obstruction as determined by the motor-test-meal has a bearing on the choice of treatment in a given case.

7. In the small intestine, retardation or eccentric distribution of the six-hour-meal is occasionally, though seldom, due to adhesions, cicatrized ulcers, tuberculous peritonitis, neoplasms or other lesions, and may thus assist in their diagnosis.

Against this list are to be set the following debits:

1. A residue incident to migraine or morphinism, or produced by other purely functional causes, may impel the examiner to seek too zealously for an organic lesion and encourage him to return a positive diagnosis on insufficient evidence.

2. If the examination is made as a routine systematically and thoroughly as it should be, the attention of the roentgenologist will not need to be stimulated or directed along particular lines by the result of the motor-test-meal.

3. Gastric motility is rarely a significant factor in sign-complexes, and present-day diagnoses do not need to be founded on minor phenomena. Stenotic deformity is almost invariably demonstrable in obstructive duodenal ulcer, and it is superfluous to look for other manifestations.

4. However small it may be, a niche or other abnormality of the luminal shadow, if constant and unchanging in aspect, does not require confirmation by a residue or any other secondary sign.

5. In differential diagnosis the result of the motor-test-meal seldom enters into consideration, and then is never a decisive factor.

6. Aspiration of the gastric contents for chemical and microscopic study is a part

of every well-ordered clinical routine, and is sufficient to decide the question of obstruction.

7. Organic obstruction of the small bowel, sufficient in degree to make it clinically important, is exceedingly rare. When it is marked, the patient is gravely ill, and if sent for examination, which is unlikely, the characteristic dilatation and columnar arrangement of the intestinal loops filled with gas and fluid is manifest in the roentgenogram without opaque ingesta. So-called ileal stasis is most often purely functional. Repeatedly I have observed slowing of the intestinal current, accumulation of the meal in the jejunum, or a diffuse segmentation of the barium contents without any lesion of the small bowel as proved by exploration.

8. Alteration of the luminal shadow is the sole unequivocal roentgenologic sign of disease in the stomach or upper segment of the small bowel. Without abnormality of the shadow, the behavior of the motor-test-meal is inconclusive or meaningless.

If this estimate is complete and fair, the net worth of the test seems scant. At the Clinic, the motor-meal has been omitted of late in an extensive series of examinations. Thus far diagnostic errors have apparently diminished rather than increased. I am reluctant as yet to urge abandonment of the motor-meal, for its record is one of distinguished service in the past, but the necessity of continuing its habitual use is at least open to question.

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DISCUSSION

Dr. R. R. Newell, San Francisco. When Dr. Imboden offered me the opportunity of opening the discussion on Dr. Moore's paper, I didn't know the very distinguished honor which was being given me, the first one to discuss a scientific paper by a newly elected president. A new president is entitled to all our honor, but as scientists we must reserve the right to differ with him on any scientific question. Such a privilege is necessary for our scientific integrity, but Dr. Moore's discussion has been so thorough and so penetrating that I have difficulty in demonstrating my independence. He has laid, I think, exactly the right stress on the importance of the six-hour motor test. Its greatest service, as he said in his first paragraph, is that an unexpected disturbance of motility will lead us to look again and look more carefully.

His experience in gastrointestinal examination is tremendous. He examines ten times as many stomachs as I do, and I should not be surprised if his first examination is more dependable than mine. Perhaps then it is more worth while that I should examine patients again and more carefully than in his case, but I do lay great stress on that recurring suggestion that you have missed something. I do agree that gastric diagnosis depends mostly on the demonstration of pathologic, anatomic signs and not primarily on discovery of disturbances of physiology—and gastric retention comes under the head of disturbances of physiology.

For myself, I wish to keep the motor meal. That it may be more dependable, I think we can look to its close control. I do not think that the patient should be allowed even water after a motor meal. Our own motor meal is exactly the same as the diagnostic meal, barium in malted milk, and nothing else. Two men in our laboratory have recently studied the effect of position on emptying of the stomach, with a barium and malted milk meal. It was easily demonstrated that if the patient lies on his left side, it takes twice as long for a normal stomach to empty as when he lies on his right side. The differences among the other positions, lying on the right side, sitting, standing, prone, and supine, were not so great; but much the quickest emptying was obtained with the patient lying on his right side. There might then be a difference in experience between those who have their patients take a motor meal at 2 o'clock in the morning so as to examine them at 8 o'clock, six hours later (in

this case the patient will be lying in bed while the stomach is emptying), and the others of us who have the patient take his motor meal at 8 o'clock in the morning, when if he is an out patient he is up and about all the time that the stomach is emptying.

I think we should know those conditions and the effect of position and activity on the emptying of the stomach if we are going to keep the motor meal as part of our examination.

Dr. Willis F. Manges, Philadelphia. I quite agree with Dr. Moore in his estimation of the value of gastric retention at six hours, but I would not want to give up that observation. I think the observation that we make from four to seven or eight hours, either four, five, six, seven, or eight hours, after the meal has been given, is not only desirable but I think it is required. It is true that we do not find a great many lesions of the small intestine, but unless we routinely make the observations during that period, we are going to miss all of them. It is the occasional case that we discover that clears up the diagnosis and leads to successful treatment. It is the sort of diagnosis on which our progress is based. We do not have any trouble any more making diagnoses of fractures, but even in fractures there are times when inadequate application of technical knowledge and skill leads to a misdiagnosis. So I think that the six-hour observation, if not the six-hour retention, is an exceedingly important thing.

Dr. Lewis Gregory Cole, New York City. Throughout this country and throughout the world at large at the present moment there is a tendency to pacifism. The days of the war are over. Many of us wish to forget it. There are many of us who have said that "if there is another war you can count me out." I am one of them. The same spirit of war that carried in the World War and the war in various countries has occurred from time to time in this Society, both political and scientific. That one of the most pacific of the meetings in the history of our Society should occur in our home town where I am perhaps considered the greatest disturber of the peace, I think is a historical event that is worthy of note.

As a culmination of this, we have the newly elected president who evidently prepared his paper without knowing the pacific character of the meeting, and without the knowledge that he would be the next president. I trust that that is true. But it seems to me that the final note of pacifism was sounded this morning when my friend "Sandy" Moore from the Mayo Clinic got up and, in his final summing up of his very careful observation of this procedure which originally was the bulwark of their method of examination and which has, up to very recently, been a very important part of some part of it, said that they had tried omitting this test meal and that, in the series of cases where it had been omitted, the accuracy of diagnosis had been increased rather than diminished. That remark seems to me the very last word of the pacific character of this meeting.

Dr. A. W. Crane, Kalamazoo, Mich. I always listen with great respect to anything that Dr. Moore says. When we disagree with anything coming from the Mayo Clinic, we have to combat a force of figures that most of us cannot match. However, I think there is something still to be said for the motor-test-meal. The results of clinicians do not always agree with the results of roentgenologists in estimating the delay in stomach emptying. I think that what the stomach does to barium alone is probably different from what it does to a real meal where the stomach is properly stimulated.

The ideal thing for the roentgenologist is to give his barium shortly before a regular meal, as for instance an ordinary noonday luncheon or dinner, and it is true that if the barium is given before that, the time of emptying must be counted from the next meal, because the barium which has mixed with the food will leave the stomach with the food and not before, of course.

Where quantitative production is the rule, as in great clinics, of course it is desirable to shorten the examination as much as is compatible with accuracy but most of us are not troubled with quantity production and the observation of a motor meal should really be an important part of our examination. It is only then that some of the rare conditions will be detected.

Some years ago it was my fortune to draw attention to the massive gastric residue which would last even longer than two days in cases of cancer of the small intestine where there was really no obstruction of the small intestine, or

at the pylorus, and yet the stomach would refuse to empty. Quite the opposite is the rule where, instead of cancer of the small intestine, there is ulcer beyond the bulb. In this case as well as in ulcer of the bulb, the stomach empties with greater rapidity. It isn't simply the matter of a gastric residue, it is the rate of stomach emptying, and when it empties very rapidly, there is a significance there as well as when it empties slowly. The whole subject of stomach emptying has to be considered in this matter of gastric residue.

There is certainly a striking difference between the action of the stomach when it is encountering cancer and when it is encountering ulcer. If there is a deformity of the antrum, which Dr. Moore spoke of, and at the same time a very rapid emptying of the stomach, almost without exception we have cancer to deal with because cancer is not obstructive except in the latest stages, even when it is a pyloric cancer. It is astonishing how rapidly the stomach will empty. On the contrary, if an ulcer is present, there is inhibition of gastric peristalsis and a prolonged retention of gastric content. If the ulcer is beyond the bulb, apparently the same reaction takes place.

It seems to me it would be a decided loss to roentgenology to put aside the motor-test-meal. We have few enough signs as it is, and the more significance we can attach to the test meal, the better.

Dr. John L. Kantor, New York City. It may not be a mistake for a gastro-enterologist to say a few words on a subject of this character. In the first place, what determines the exact emptying of the stomach is not the amount of barium or bismuth you put in there but the character and the amount of menstruum in which you mix it. Perhaps it is well to carry these standards in mind: if you give a stomach a pint of water, it will take a little bit less than half an hour to empty. If you mix with that pint of water four Uneeda biscuits, the stomach takes an hour and a half for emptying. If you take a milk meal, it takes five hours for one pint of milk, and that holds good for milk modifications, malted milk, fermillac, and the old cereal pap as we gave it with cream, cooking it very carefully, in 1914 and 1915.

Dr. Crane will be interested to recall, as he perfectly well knows, that it takes about seven hours for a standard meal to empty, that is the ordinary human fodder that we would like to give. That is, of course, ideal, but seven hours is a relatively long interval and we have to speed up. Besides, a standard meal of that character would vary too much with individual tastes and would not do for practical purposes.

Instead of giving up the six-hour meal, I would ask you to consider particularly in the light of Mills' work the question of getting a little finer standard and accepting five hours as the proper emptying time. I, personally, have given up the six-hour meal and substituted the five, and I have no hesitation in recommending a five-hour interval as the best interval for all-around work.

Finally, it may be well to remember that a gastric residue associated with severe headache may be due to caffeine deprivation in patients habituated to the use of coffee for breakfast. In such cases it may be wise to repeat the motor meal adding a little coffee to the barium mixture. In that way the stomach may be found to empty normally on reexamination.

Dr. Alfred L. Gray, Richmond, Va. I feel that we ought not to abandon the six-hour examination, not especially because of possible gastric retention, or on account of any further information concerning the duodenum, although sometimes at six hours we get a much better filling of the duodenal bulb if there has been a gastric retention than we do in the primary examination. I think that we ought not to give up the six-hour observation that Dr. Kantor prefers, without providing in some way for the information that we now obtain from that examination.

Dr. Leopold Jaches, New York City. My experience has been that the six-hour meal per se has no great value. You will find quite frequently in the same patient who has been examined under exactly the same conditions a residue at one time and none at the other, and we cannot account for the difference. But I would not give up the six-hour or five-hour or even the four-hour observation for another reason, and that is for the sake of a study of the small intestines. I do believe that we really ought to go back to the very early method when we were observing these patients sometimes two hours, four hours, and six hours after the meal. I know it is a nuisance; many patients will complain about it, and we will have more to do than we have now. Although

the number of lesions in the small intestines is rather small, we nevertheless would then be able to pick up quite a few which we are missing today.

Dr. Cole. May I add one word? I gather from Dr. Moore's paper that he referred to lesions of the stomach rather than the small intestines. One cannot make a study of the small intestine without putting barium into it. However, it is my opinion that examination should follow a stomach examination and should be made with a specially thick barium paste. It takes us about twenty minutes to make our regular gastric examination of twenty-four films in three different directions. At the end of the gastric examination, a half hour after the barium is taken, we make what we call our half-hour plate and then we make one at two hours and four hours and six hours. We haven't abandoned that. It is the question of giving a pap meal in the morning and then following it up six hours later with another examination; i.e., the two-meal method is the thing to which I object; the double meal is a thing which I think complicates the diagnosis.

Dr. Moore (closing). Dr. Cole, as usual, is right. The title of this paper should have been, "An Appraisal of the Motor Meal in the Examination of the Stomach and Proximal Small Bowel."

It seems to me that all of us are prone to discuss methods and lose sight of the important thing, and that is the result. This is not an attempt to persuade you to abolish the six-hour motor meal. It is intended simply to stimulate us to ask ourselves whether it is really worth while. I am not saying that it isn't, but my impression is that we can get on without it very well.

In reference to Dr. Newell's remark about the study of physiology, roentgenologically, I question whether we know very much about physiology by any of the methods that we are using, if physiology means the normal function.

If we are going to use a six-hour motor meal, we must have a standard meal for our routine work. Dr. Crane's method is to give the barium before an ordinary meal. Dr. Crane knows how the normal stomach reacts to such a meal. When we used the six-hour meal, we used a small meal and we took six hours as a basis because in our experience a residue at the end of six hours usually meant something. I think one can take five hours or four hours, provided the size of the meal is proportional to the time.

As to what Dr. Crane said concerning the disturbances in peristalsis, I agree with him heartily that it is the infiltrating lesion that causes rapid emptying. It has not been my experience to see any disappearance of peristalsis in ulcer until complete obstruction ensues and the stomach is so fagged out that it will not react. Usually hyperperistalsis accompanies ulcer.

I feel that when we attempt to diagnose functional disorders with the roentgen ray occasionally we are getting on pretty dangerous territory; we are skating on rather thin ice. We can exclude the organic, but I wonder how often we can accurately diagnose the functional.

With respect to Dr. Gray's statement about the study of the cecum, this paper was not intended to get beyond the duodenum. I think, though, that the liquid suspension can be followed through the small bowel either by roentgenograms or by fluoroscopic examination; however, in my experience the study of the cecum is much more satisfactory with the enema than by tracing the meal from above.

In regard to what my friend Lewis Gregory Cole has said, I am glad that Dr. Cole has realized at last that I have worshipped at his shrine for many years and that I am indebted to him for many of the things that I know and I am not indebted to him for all of the things that I do not know. I appreciate what he said today.

HYPERTROPHIC PYLORIC STENOSIS IN ADULTS: ROENTGEN ASPECTS*

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THIS subject was brought to our attention by three recent operative cases. In one of these the preoperative diagnosis was carcinoma of the pylorus, and in the other two, gastric or pyloric ulcer. At operation all three showed a condition with which we were unfamiliar, and concerning which the literature revealed little. In this contribution, the roentgen findings will be stressed. The surgical aspects will be presented by Morton in another communication.

According to Maier, congenital hypertrophic stenosis in infants was first noted by Landerer of Freiburg in 1879. Since that time it has been studied extensively. The condition on which this communication is based is apparently a definitely different clinical entity. Hypertrophy of the pylorus in adults was first noted by Maier, who found 31 cases at autopsy, in subjects ranging in age from twelve to seventy-five years. He considered the hypertrophy congenital in origin, and believed that it explained many cases of dilatation and stenosis in young adults. Maylard in 1904 described 7 cases in which he operated for peptic ulcer but found no evidence of ulcer either on the mucosal or serosal surfaces. In all seven of these cases the pyloric sphincter was so contracted that it would not allow the passage of the tip of the index finger. These patients ranged in age from twenty to forty-six. A gastroenteric anastomosis was made in all, with uniformly good results. He believed that the condition was due to a congenital thickening or reduplication of the mucosa.

Mayo-Robson and Moynihan in 1904 reported Hussey's case of a boy eleven years of age who had vomited since infancy. At operation a thick pylorus was found. A gastroenteric anastomosis was made which afforded relief.

Mayo-Robson reports his own case of a twenty-four year old male, who had indigestion for five years, with a gradual painless onset. At operation, a thick pylorus was found which was stretched digitally. This gave improvement for three months after which time the symptoms recurred to such an extent that a gastroenteric anastomosis was made. This gave permanent relief to the patient.

Osler and McCrae in their textbook give four lines to this condition in adults. Bastianelli in 1925 reported 4 cases in which roentgenologically there was pylorospasm without retention. All four patients had a preoperative diagnosis of duodenal ulcer or probable duodenal ulcer, both from the clinical and roentgen studies. He operated on these cases and found no evidence of ulcer, erosion, or fissure, but found the pylorus thick, the thickening being sharply limited to the pylorus. Microscopic sections showed inflammatory changes without ulcer or scar. A Rammstedt operation was done on these cases, with relief in all four. Bastianelli called this condition "pyloritis," and thought that it could best be explained as a consequence of local gastritis.

Bianchetti in 1926 described a case of so-called circular myoma of the pylorus in a patient aged sixty-one, who had all the clinical evidence of a small pyloric malignancy with obstruction. There was no free HCl in the gastric contents. At operation a thick pylorus was found which would not admit the tip of the index finger. Believing the thickening malignant, a gastric resection was done. The excised

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portion showed hypertrophy of the muscular fibers microscopically.

Crohn in 1928 reported the case of a woman forty-five years old who had vomited all of her life. Roentgen examination showed an obstruction, with 75 per cent residue at six hours, and an appreciable gastric residue at forty-eight hours. At operation this patient was found to have a thick pylorus, as large as the operator's finger, but there was no evidence of ulcer or carcinoma. The pylorus was softer than in the hypertrophic pyloric stenosis of infants. A pyloroplasty was done.

Chaney in 1928 reported the case of a colored woman twenty-five years old. The duration of symptoms was ten months, in which time the patient lost 109 pounds in weight, and had nausea, vomiting and epigastric pain. Roentgen examination showed almost complete obstruction at the pylorus, with an almost complete gastric residue at five hours. At operation a thick pylorus, 4 cm. wide, was found, with a second band 1.5 cm. proximal to it. In a personal communication, he cites a similar additional case occurring since the publication of his article.

The action of the pylorus in normal individuals has been studied by Cannon, Cole, Pawlow, Alvarez, McClure, and others. Cole in 1913 showed roentgenologically that the pylorus was closed except when it opened to eject gastric contents. Considerable pressure was necessary to cause the passage of the gastric contents, and then only with the added impetus of gastric peristaltic waves. Cannon advanced the theory suggested by Pawlow and others, that the acid-base relationship controlled the action of the pyloric sphincter; acid on the gastric side causing relaxation, acid on the duodenal side causing contraction. McClure and Reynolds in 1921 showed that the introduction of acid into the duodenum had no effect. They observed the pylorus under the roentgenoscope after a barium meal. Alvarez and Mahoney in 1923 studied the relation between gastric and duodenal peristalsis, and concluded that such a relation did exist. They concluded that the pylorus acts as a partial barrier to gastric peristalsis, preventing it from sweeping uniformly into the duodenum. Martin and Burden in 1928 discussed pyloric achalasia. According to them, the term pyloric achalasia as defined by Hurst is the failure of the sphincter to relax. This pyloric dysfunction is given by them as a cause of many ulcer syndromes in which no ulcer can be demonstrated.

A brief consideration of the normal pyloric structures will be of aid in the conception of pyloric dysfunction. According to Jordan the pyloric portion of the stomach consists of the following concentric layers: the serous coat, the muscular coat, the submucosa and the mucous coat. The serosa extends unchanged from the stomach proper into the pylorus. The muscular coat of the stomach consists of two layers of smooth muscle fibers—a thin outer longitudinal, and a much thicker inner circular and oblique layer. The longitudinal fibers are most abundant toward the cardiac and pyloric orifices. The circular fibers are the thickest of the layers and at the cardiac and pyloric orifices become well developed to form sphincters. The submucosa consists of loose areolar tissue supporting blood vessels, lymphatics and nerves. The mucosal coat consists of the muscularis mucosae which supports the gastric glands. The glands differ considerably in various sections of the stomach. The pyloric glands occupy the lower fifth of the stomach, there being a gradual transition from the glands of the fundus to those of the pylorus. It is the derangement of anatomical structures with which we are concerned in this contribution.

Congenital hypertrophic stenosis in infants has been thoroughly studied. As the name implies, this condition is due to hypertrophy of the pyloric musculature causing stenosis. Of course, there are

varying degrees of obstruction, ranging from almost complete blockage down to slight retardation in emptying. The treatment varies according to the severity of the symptoms. According to Holt, Heubner, Bendix, Hutchinson, and others, a fair percentage of these cases recover on medical treatment. If symptoms are severe, surgery must be resorted to.

When a section of the pylorus from a case of congenital hypertrophic stenosis of the pylorus is examined microscopically the condition is found to be very largely due to hypertrophy of the muscularis and submucosa, particularly of the circular muscular fibers. Bastianelli in his cases in adults, shows muscular hypertrophy, with inflammatory changes.

The clinical picture of the infantile type varies with the degree of obstruction, the typical case according to Chapin and Royster being as follows: Within two to four weeks after birth the child begins to regurgitate its food after nursing, followed in a few days by distinct vomiting which in a few days more becomes projectile in character. The stools become smaller and smaller and the child loses weight very rapidly. When stenosis is slight, there may be only occasional attacks of vomiting. This type of case is amenable to nonsurgical treatment.

In adults, the obstruction is less complete, and milder symptoms, therefore, are the rule. Here again, the clinical picture depends upon the degree of obstruction. Sometimes the patient complains only of vague indigestion, with a feeling of fullness or heaviness of the stomach. Frequently this is accompanied by loss of weight, and not infrequently is associated with an undernourished individual. The severity of the symptoms depends largely upon the duration and the extent of the obstruction. The duration of the symptoms depends upon the same factors. The age of the patients is variable, the cases in the literature varying from the second to eighth decade, our cases ranging from thirty-nine to sixty-three years of age.

The diagnosis of these cases must be made chiefly on the basis of the roentgen findings. The appearance varies, of course, with the extent of pyloric involvement, but the chief feature is a persistent, practically unchanging, hiatus between the stomach and duodenal bulb due to an increase in the extent of the pyloric ring. This may or may not be associated with spastic incisurae of the pyloric portion of the stomach several centimeters distant from the pylorus. Antispasmodics given to physiological tolerance have no effect, and vigorous palpation under the roentgenoscope over a long period of time causes practically no change. The barium stream is very narrow, the pylorus never opening up to discharge as in normal individuals.

The differential diagnosis in these cases may be quite difficult or impossible. In an elderly patient, with a broad pyloric ring, it is impossible to differentiate between a small obstructive scirrhous carcinoma and hypertrophic pyloric stenosis. In our first case of hypertrophic stenosis, this was called carcinoma, since it was unchanged in appearance on two examinations after atropine had been given to the physiological limit. The tissue factors are the same, but in one case the overgrowth is benign, and in the other malignant. A small ring ulcer will give the same type of pyloric deformity, the incident spasm producing a distinct widening of the breadth of the pylorus. Simple pylorospasm can usually be eliminated by intermittent examination over several minutes, and noticing the change of lumen, or by the administration of antispasmodics such as atropine, belladonna, or one of the nitrites. Vigorous manipulation along with a gastric peristaltic wave, will many times open up the pyloric sphincter, so that a rush of barium will occur. In hypertrophic stenosis the caliber of the pylorus is unchanged under practically all conditions,

even the deep anesthesia of an abdominal operation.

A brief protocol of our three cases will serve to illustrate practically all of the points mentioned above.

Case I. C. D., white, male, aged sixty-one, admitted to the hospital January 5, 1926, complaining of "stomach trouble." His general health had been good until five months prior to admission, at which time he began to have slight epigastric soreness and discomfort. He had lost 25 pounds during this time. There had been occasional vomiting unrelated to mealtime or food. The physical examination was negative except for slight epigastric tenderness. The Wassermann reaction was negative. Gastric analysis: No free HCl, positive for lactic acid.

Roentgen Examination. Peristalsis hyperactive, with a constant narrowing of the lumen of the pylorus over an area of 2 to 3 cm., which was unchanged during roentgenoscopic examination and on films. There was no six hour retention. The examination was repeated under full atropinization to eliminate spasm, with the same findings as noted above.

Roentgen Diagnosis. Small non-obstructive carcinoma of pylorus.

Operative Findings. Upon opening the abdomen, an elastic mass about 2 cm. in diameter was found encircling the pylorus. This did not have the consistency of malignancy. The stomach was incised for possible interior malignancy, but none was found. A Rammstedt operation was performed on the pylorus. *Postoperative Diagnosis.* Quoting from the surgeon's report: "Pylorospasm with hypertrophy, similar to congenital hypertrophic stenosis of infants." Since recovery from the operation, the patient has been able to work every day. In a recent follow-up letter his physician stated that the patient still has occasional nausea, associated with fatigue, but does not vomit.

Case II. C. T., colored, male, aged forty-two, first admitted to the hospital in 1916 for hemorrhoid operation. At that time he stated that he had had some indigestion for six months, but no investigation of his gastrointestinal tract was deemed advisable. In 1922 he was readmitted on account of "stomach trouble." Two years prior to this admission he had had several attacks of soreness in the right upper quadrant, under the costal margin, lasting from two or three days up to a week. Six months prior to admission, a similar attack had come on, from which he had had no relief. There was no nausea or vomiting.

Roentgen Examination. Stomach and duodenum negative except for intense pylorospasm and a constant incisura on the greater curvature 3 cm. proximal to pylorus. A fixed retrocecal tender appendix was found.

Diagnosis. Chronic appendicitis. *Operation.* A right rectus incision was made, and the appendix was found tied town and retrocecal as described. This was removed. The stomach, duodenum, gall-bladder, and pancreas were examined and were described as normal.

The patient was readmitted April 4, 1928, for "stomach trouble." He stated that his symptoms were relieved for about four months after operation, but had returned.

Roentgen Examination. Pylorospasm, with the same incisura noted on former examination. No six hour retention, but with the head of the meal in the descending colon. *Roentgen Diagnosis.* Probable small ulcer near pylorus, too small to be seen, but giving irritative hypermotility.

Laboratory Examination. Wassermann reaction negative, gastric analysis (several) varying, but all showing marked hyperacidity up to 75 per cent.

Clinical Diagnosis. Peptic ulcer.

Operative Findings. No external or internal evidence of ulcer. The lining mucosa of both stomach and duodenum was carefully examined. The mucosa in the prepyloric region had a granular appearance. The pylorus was unusually small so was stretched manually. *Operative Diagnosis.* Hypertrophy of pylorus.

Clinical Course. This case followed closely the course of the case cited by Mayo-Robson. The patient improved greatly after the operation, but in five months he began to have a return of his symptoms. He has been advised to have a pyloroplasty performed, but has not yet returned.

Case III. A. L. J., white, female, aged thirty-nine, admitted May 8, 1928, on account of "stomach trouble." For one year prior to admission she had had fullness in her stomach immediately after eating, often followed by pain; she occasionally had nausea, but no

vomiting. In the few weeks immediately prior to admission she had vomited often. She had lost considerable weight, but did not know how much.

Roentgen Examination. Marked pylorospasm, with a small irregularity of the lesser curvature just at the pylorus, suggested ulcer induration without a "fleck." The duodenal bulb was normal. At six hours there was a gastric residue estimated at 25 per cent. A reexamination gave the same findings. *Roentgen Diagnosis.* Probable small ring ulcer, with partial obstruction. This was based on the pyloric irregularity and the gastric residue.

Clinical Diagnosis. Peptic ulcer with obstruction.

Operative findings. The stomach and duodenum were negative externally and an incision showed no evidence of ulcer or fissure. The pylorus was definitely thickened, the lumen being quite small. On account of this, the anterior portion of the pyloric musculature was removed and a pyloroplasty was done after the method of Horsley, Judd and others.

Pathologic Findings. Hypertrophy of pylorus. Microscopic examination of the excised tissue shows "slight diffuse round cell, plasma cell, and polymorphonuclear infiltration and considerable vacuolar degeneration of the muscle. There is edema in the submucosa."

Pathologic Diagnosis. Acute and chronic inflammation of the pylorus.

Clinical Course. Since operation, the patient has gained 30 pounds and is enjoying the best health she has ever known.

DISCUSSION

Adult hypertrophy may possibly be a residuum of the congenital form which has been relieved, the symptoms returning later in adult life. It is possible theoretically that slight obstruction in infants might be overcome by a secondary gastric hypertrophy. After many years, the gastric musculature might become atonic, and the symptoms could reappear, or functional spasm might be implanted on the already existing hypertrophy, and symptoms would appear. Another possible explanation of the adult type is that long-continued functional spasm might produce hypertrophy in an otherwise normal pylorus.

Judging by the lack of adequate description in the literature, this condition has seldom been recognized, and must be more common than one would be led to expect from reading. Soon after we had encountered the third case reported in our series, there came an opportunity to talk this condition over with Dr. Alexander Moore of the Mayo Clinic. He stated that several similar cases had come under his observation.

It is our belief that hypertrophic pyloric stenosis in the adult is a definite disease entity, and that it causes a definite syndrome. We have under observation about 10 of these cases in whom this tentative diagnosis has been made, and believe that several will be forced to operation on account of the increasing severity of their symptoms. It is also believed by us that hypertrophic stenosis, when marked, can be differentiated from simple persistent pylorospasm by careful roentgenoscopic examination. Undoubtedly spasm due to reflex irritation may be an etiological factor, and if long continued will lead to hypertrophy. Consequently there is a rather wide border zone between simple spasm and hypertrophic stenosis, in which a definitely accurate diagnosis cannot be made.

From the roentgen standpoint, the two signs which lead us to suspect hypertrophy are first, a persistent, practically unchanging, increase in the breadth of the pyloric ring present on repeated examination and not amenable to antispasmodics, and second, a six hour gastric residue. If an appreciable six hour residue is present together with the increase in breadth of the pyloric sphincter, it is believed that the diagnosis is practically as positive as the usual diagnosis of ulcer or carcinoma. If roentgenologists will recognize this condition, it is believed that many patients will be benefited by the institution of proper treatment after diagnosis. Judging

by our experience, there are undoubtedly many cases now labeled "pylorospasm" who could be definitely restored to health if the true cause "hypertrophy" were recognized and treated.

SUMMARY

A rather careful study of the literature reveals only a few contributions on hypertrophic pyloric stenosis in adults. This is particularly true of the roentgen literature. The literature, anatomy, and pathology have been briefly reviewed. The etiological factors are probably long-continued spasm, a residuum from congenital hypertrophic stenosis, or a combination of both. Three cases have been reported in this communication all proved by operation, and the postoperative courses have been followed. The chief roentgen finding is an unchanging increase in the breadth of the pyloric sphincter, sometimes associated with a prepyloric incisura. The advanced cases may have a six hour gastric residue. Treatment in the pronounced cases is surgical, some type of pyloroplasty being the operation of choice. In the milder cases, a modified diet may prove beneficial.

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THE CLINICAL EFFECTS OF THE INHALATION OF NITROGEN DIOXIDE*

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IN THIS discussion it is my purpose to attempt to show the clinical and anatomical effects of the inhalation of gases generated by the decomposition of roentgen films of the nitrocellulose type and also to discuss briefly the treatment.

A number of toxic gases are generated by the flameless combustion or decomposition of nitrocellulose roentgen films. The amount of gas generated is dependent upon several factors: the temperature, the amount of pressure, and the amount of oxygen present.

Various investigations have been made, one by the Chemical Warfare Service, as to the processes which lead to the decomposition of nitrocellulose products, these investigations having been made with a view to formulating law codes for the storage of roentgen films. It is not my purpose to discuss this phase of the matter at this time. These reports will be published and will doubtless soon be expressed in the law codes of the various states. What I wish to emphasize is merely the practical aspect of the matter, since the practitioner is concerned, not with methods of storage of roentgen films, but with the character of the lesions produced by gases that may be formed from their decomposition and the proper treatment of the victims.

The gases produced by the decomposition of nitrocellulose films are carbon monoxide, nitrogen dioxide, carbon dioxide, nitrous oxide, and hydrogen cyanide. Of these, carbon dioxide and nitrous oxide are non-lethal, but the latter on exposure to the air is quickly transformed into nitrogen dioxide, the lethal characteristics of which will be discussed later. Carbon monoxide constitutes practically one-third of the total volume of the gas which is generated. The inhalation of carbon monoxide is a rather common accident and its asphyxiating effect is well known, the combination of carbon monoxide with the hemoglobin rendering the latter incapable of carrying oxygen. Nitrogen dioxide, a corrosive and deadly gas, is formed in large quantities, this gas constituting another third of the total volume of gas generated. In the presence of water or moisture nitrogen dioxide liberates free nitric acid. This process must be kept in mind in considering the effect of the inhalation of nitrogen dioxide, as when the moisture in the lungs comes in contact with this gas, nitric acid is liberated, with resultant disastrous effects on the tissues of the lungs. Hydrogen cyanide is a very poisonous gas and if any appreciable quantity is produced, it might account for some of the early and instant deaths.

The effect of the inhalation of nitrogen dioxide may vary from slight edema of the lungs which is manifested by the expectoration of bloody rusty-colored mucus, to an overwhelming edema which causes the patient literally to be drowned in his own fluids. Death may take place within a few hours after inhalation, it may be delayed for days. Recovery may take place weeks after stormy periods at intervals during which life is despaired of. Whether or not ultimate recovery is complete remains to be established.

The possible lesions which may occur are well illustrated by the post-mortem report of one of our cases in which the following conditions were found: acute tracheobronchitis (slight); extensive pul-

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monary edema; widespread degeneration and necrosis with regional thrombosis and hemorrhage especially in the kidneys, lungs, myocardium, brain, esophagus, and duodenum; multiple infarcts in the lungs and kidneys; multiple areas of recent myomalacia; erosion of the duodenum and the lower third of the esophagus; focal superficial necrosis of the mitral and triscuspid valves with overlying fibrin thrombi; multiple areas of hemorrhage in the walls of the coronary arteries and regional tissues; hydrothorax amounting to 1000 c.c. on the right side and 600 c.c. on the left; early bronchopneumonia; cardiac dilatation. This patient died a week after the disaster,* growing progressively worse with increasing delirium until a comatose condition supervened.

In another case in which death occurred twenty-five days after the disaster the post-mortem examination revealed subacute interstitial pneumonitis; pulmonary congestion and edema; bronchopneumonia; purulent bronchitis; fibrous pericarditis, synechia cordis; hypertrophy and dilatation of the heart, especially on the right side; interstitial myocarditis, right and left ventricles; vegetative endocarditis, mitral valves; mural thrombus, right auricle; atheromatous plaques at the base of the aorta and pulmonary arteries; cloudy swelling of the heart, liver and kidneys; fatty infiltration of the liver; multiple healing infarcts in the kidneys; fibrous and fibrinous pleuritis, bilateral; cyanosis; anemia; calcareous plaques in the dura of the brain.

In a case which died a few hours after the disaster the following gross conditions were found: Acute pulmonary congestion and edema; acute dilatation of the right heart; petechial subendocardial hemorrhages in the left ventricle, stomach and small intestines; cyanosis; blood concentration; hemolysis.

It is unnecessary to give here the gross and microscopical findings in these post-mortem examinations. These will be published elsewhere in detail. These summaries, however, are sufficient to indicate how far-reaching may be the effects of the inhalation of nitrogen dioxide and how prompt, persistent and meticulous must be the treatment.

Before describing the clinical course of patients who have inhaled this corrosive gas it may be well to state that while clinically the patients' chests often appeared to be clear, the roentgenograms always revealed numerous small nodular areas scattered throughout both lobes. This nodular infiltration was interpreted as an exudative infiltrate and an interstitial fibrosis which was, we believe, due directly to the irritant effect of the poisonous gases on the lung tissue.

It seemed to us that the small areas of infiltration which were first seen were truly exudative in character. These appeared on the films as rather pale, apparently translucent shadows. In this stage there was clinical evidence of moisture in the lungs—extensive moist bubbling râles; the patients suffered extremely from difficult respiration and cyanosis was marked. A roentgenogram of such a chest taken two weeks later showed extensive, dense, rounded nodules which were interpreted as due to interstitial fibrosis, and were proved to be so by post-mortem examinations. These areas were almost identical in appearance with those seen in miliary tuberculosis and in some types of miliary metastases or pneumonoconiosis. Roentgen examinations of these chests were made at weekly intervals, the successive films showing a gradual fading out of the lesion. At the present time in at least two cases the lungs appear to be normal as far as can be determined by roentgen examination. The cardiac impairment in each case which was directly due to the edema and interstitial pneumonitis, was not demonstrable roentgenologically.

The clinical course in those individuals who were hospitalized immediately after

* At the Cleveland Clinic, May 15, 1929.

the disaster was rather prolonged and was marked by definite phases or relapses. On admission the patients showed a rather marked cyanosis which progressively increased. The clinical picture at this stage was characteristic of an acute pulmonary edema. Early laboratory data showed a marked concentration in the blood, and gave no evidence of reduction of the hemoglobin. The oxygen-carrying capacity was normal or slightly diminished. Most of the red blood counts taken early showed a polycythemia, the red cell count varying from 5 to 8 million. As the condition improved there was a tendency toward anemia, the count varying from 2,500,000 to 3,000,000. This anemia could perhaps be explained as due to an attempt to neutralize the presence of the nitric acid formed in the lungs.

During the first seven days after the disaster, from May 16 to May 23, there was a gradual improvement in the condition of these patients, the temperature, pulse and respiration gradually assuming a normal rate. Following this they remained normal as far as their clinical charts were concerned until May 30—fifteen days after the disaster—when they again showed a rise in temperature, acceleration of pulse and respiration and marked cyanosis, these symptoms appearing in all respects identical with those of the initial illness. From this time on, the course was rather slow, the temperature, pulse and respiration returning to normal about July 4—fifty days after the disaster. The cyanosis varied considerably, sometimes being very marked. In some cases it was not relieved even by a high concentration of oxygen, but was affected by the position of the patient; that is, the patient could be relieved by being placed on his right side. Upon being discharged from the hospital practically all patients noticed a very marked response to effort, which has, in some cases, persisted to date.

In the case of those patients who were admitted to the hospital on the day of the disaster with a very marked acute pulmonary edema with cyanosis, the pulse was imperceptible, and no therapeutic measure was of any avail. Practically all of these patients died. In some cases, the edema was so marked that frothy material flowed very freely from the nose and mouth.

The treatment instituted in the early stages consisted chiefly in venesection and transfusion and the intravenous injection of saline and Fisher's solutions, together with massive doses of atropine, caffeine, soda benzoate and ergotol. Codeine and morphine were used as sedatives. In several of the cases an immediate increase in the pulmonary edema, and death, followed transfusion. In the early stages venesection followed by intravenous Fisher's or saline solution seemed to result in the best clinical improvement. Venesection was very difficult because of the concentration of the blood. In some cases it was necessary to massage the arm in order to obtain any blood at all. Atropine apparently controlled the edema of the lung to only a small degree as was the case with ergotol. At all stages codeine appeared to be the best sedative.

The administration of oxygen through intranasal catheters was inadequate, the cyanosis being in most instances unchanged. In the earliest stages oxygen administered under pressure from a gas bag with a tight fitting mask seemed to force oxygen through the fluids in the lung and relieved the cyanosis. The institution of the Roth-Barach oxygen tents after the initial edema resulted in a very marked improvement in the patients who survived. These tents were not available in the early period so it is difficult to say what effect they would have had in the earliest stages, but all who survived the first four days and were placed in oxygen tents showed a complete disappearance of the cyanosis when the concentration of oxygen in the tent amounted to between 40 and 50 per cent. This was the case until May 29

and 30, when the patients had relapses and the cyanosis became more intense. It was then found necessary to maintain the concentration of oxygen in the tent as high as possible—from 60 to 70 per cent as estimated—and even then in most instances the cyanosis was not completely relieved. After the institution of the oxygen tents, the drug therapy was reduced to a minimum, and consisted chiefly of sedatives—codeine, allonal, and occasionally morphine and pantapon. Another drug used in this period was digitalis which did not seem to affect the pulse in any way or to lessen the cyanosis. Codeine in gram doses every two hours was sufficient to give the patient rest and to relieve the tracheal reflexes which were causing violent fits of coughing. No other single drug seemed to be as effective for most of the complaints as codeine. Allonal, or luminal in some instances, was the best hypnotic.

Perhaps the outstanding points in the treatment could be summarized as to their importance and efficacy in the following order: continuous oxygen therapy; sufficient codeine to relieve the troublesome cough and to afford relaxation, and the use of other sedatives such as allonal, luminal and amytal. At first it was considered necessary to keep the water intake at a very high rate—between 3000 and 5000 c.c. but later the intake was reduced to between 2500 and 3000 c.c.

The clinical course and treatment described above pertains to the victims of nitrogen dioxide poisoning. The signs and treatment of carbon monoxide poisoning require no extensive description but it may be well to cite the following excerpt from the report issued by the Chemical Warfare Service to which we have already referred:

> If the patient has not lost consciousness, getting him into the fresh air will generally be all that it is necessary to do. Mild stimulation, such as the inhalation of aromatic spirits of ammonia, is of some value.
>
> If the patient is unconscious but breathing, pure oxygen should be administered, preferably under pressure through a mask. Oxygen accelerates the discharge of carbon monoxide from the blood. Stimulants such as camphor, caffein, and strychnine should be given hypodermically. General massage should be practiced to improve the circulation and restore the oxygen balance. The patient must be kept warm.
>
> If the patient is not breathing, artificial respiration (Schaeffer method) must first be employed, and then the measures of the preceding paragraph resorted to. If recovery is not prompt, the inhalation of a mixture of carbon dioxide, 5 per cent, with oxygen, 95 per cent, recommended by Haggard and Henderson, should be used. Venesection, with the introduction of normal (physiological) salt solution, has been employed with especially good results.
>
> In some extreme cases in which the respirations have ceased and the heart has stopped or almost stopped, Crile and Lenhart have shown experimentally that more than 50 per cent can be saved by blood transfusion, while without this all other methods are of no avail.

As stated in the beginning of this paper my purpose has been merely to call attention to the outstanding features in the clinical course and treatment of patients who have been subjected to poisoning by the inhalation of the gases formed by the combustion of nitrocellulose products—for there are other products than roentgen films the combustion of which may produce identical results.

The general physician should be prepared to offer the most efficient treatment in the presence of such an emergency.

DISCUSSION

Dr. Leon T. LeWald, New York City. Dr. Nichols used the term "fibrosis" and then showed signs of the condition rapidly clearing up. Unless he has the histological demonstration of this fact, I wonder if he would explain whether it was an acute exudative inflammation rather than perhaps one with some cellular changes that did not go on to what we ordinarily understand as interstitial changes.

DR. A. H. PIRIE, Montreal, Canada. I would like to ask if, in that appearance of miliary tuberculosis, Dr. Nichols took stereoscopic pictures and if he did not find the miliary appearance running in lines. I have seen the same after inhalation of poisonous gas in which I diagnosed miliary tuberculosis without knowing what was the matter with the patient and then I found on stereoscopic examination that the appearance of miliary tuberculosis ran in lines following the lines of the bronchi and bronchioles.

DR. NICHOLS (closing). In regard to Dr. LeWald's question, our interpretation of this nodular fibrosis was definitely confirmed by the pathological specimens from the cases that succumbed to the disease. These nodules were around the bronchi and were definitely interstitial in character. We are well aware of the fact that these did not conform to the usual findings of a fibrosis but our pathologist assured us that these were interstitial fibrous nodules of a rather acute character.

In answer to Dr. Pirie's question I would say that we made no stereoscopic films of these patients as they were all very sick and in oxygen tents and it was necessary to do them quickly with a bedside unit; but I feel that our post-mortem findings in these cases demonstrated clearly that these were interstitial fibrous nodules and not the ordinary striated or stringy type of fibrosis we usually see in the lung.

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THE POSITION OF ROENTGENOLOGY IN THE UNDERGRADUATE MEDICAL CURRICULUM AS SEEN BY RECENT GRADUATES

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THE growing importance of roentgen diagnosis and therapy in medicine has of late focussed attention upon its pedagogic aspect. The organization of teaching departments in the medical schools of the United States has been considered by Hickey, Bass and others. Because of the rather divergent opinions expressed regarding the place of roentgen diagnosis and therapy in the undergraduate curriculum, it was thought that a study of the viewpoint of the graduate of medicine would be interesting. Accordingly, a study of the teaching of roentgenology has been made, especially from the aspect of the recent graduate of medicine. It is our aim to coordinate these opinions with the organization of the roentgen courses as given in the respective medical schools, in order to determine whether the instruction has been comprehensive and adequate, and if not, how it could be improved.

Questionnaires were sent to the deans of all Class "A" medical schools asking for the following information: (1) Under what department the teaching of roentgenology is carried out; (2) whether or not full professors are in charge and whether the teachers are full time specialists in their subjects; (3) details as to the amount and character of the courses. In addition the following questions were asked: (1) Do you consider that the undergraduate students show an unusual interest in roentgenology? (2) Do you consider that the medicals schools of the United States, as a whole, give adequate and comprehensive courses in roentgenology? Sixty-five replies were received from Class "A" schools throughout the country.

Questionnaires were also sent to 125 recent graduates of medicine, the majority having been graduated three years or less, asking, first, whether they thought that the courses had been adequate and comprehensive, and if not in exactly what way they were deficient, and whether they had any suggestions for improvement. Replies were received from 100 graduates representing 40 medical schools distributed over the United States. The replies from both questionnaires were tabulated under the medical schools attended, and the results were correlated. This method is open to the objection that a graduate of three years has not had sufficient experience to appreciate possible deficiencies in the curriculum, but a longer period of time might represent a lack in the instruction which has since been remedied. We realize, of course, that the series is a small one but it is probably large enough to give the trend of opinion.

The analysis of the mass of information received is difficult. The tendency in this type of work is to allow the statistics to reflect a personal bias. For the sake of clarity it has been thought best to consider the subject under three heads: (A) Quality of instruction. By this we mean the ability of the instructor to impart knowledge and arouse enthusiasm. (B) Time devoted to the subject. (C) Type of instruction. By this is meant whether the instruction is given in formal lectures, section work or clinical conferences, etc.

(A) *Quality of Instruction.* From a study of the organization of a teaching staff a fairly good estimate of the ability of the teachers can be obtained, but it does not aways follow that the most inspired instruction takes place in the most highly

organized department. In this connection the opinion of the recent graduate is most valuable, for it takes a student only a short time to determine whether an instructor is a good teacher. Seventy-two of the graduates answering the questionnaire were satisfied with the instruction received. Often one would express the opinion that the teaching was good but that there was not enough of it. Relatively few graduates (28) complained that the teachers could not teach. Taken as a whole, however, comparatively little dissatisfaction was expressed with the quality of instruction.

(B) *Time Devoted to the Subject.* Sixty-four of the graduates were dissatisfied with the amount of time allowed to the subject. Of this group 60 wanted more time, while only 4 thought that there was too much time devoted; 36 were satisfied with the time as given. In view of the overcrowding of the undergraduate medical curriculum, the fact that there is a desire for more instruction is significant. We believe that this shows a general interest and keenness of the students for roentgenology. In this connection those who answered the questionnaires sent to the medical schools as to whether there was an unusual interest among the students, 58 per cent said that there was an unusual interest, corroborating the statements made above.

The average total scheduled time, excluding electives, of the institutions attended by those who were dissatisfied with the amount of time devoted was forty-one hours, indicating that this is insufficient. That the present ways of teaching medicine are not satisfactory is suggested by the various new methods which are being tried in different institutions. After all, the aim of a medical school should be to give good grounding in the fundamentals of medicine and surgery. It would be unwise to attempt to make a specialist of a medical student, yet we devote a tremendous amount of time to the teaching of surgery, for instance, without a thought of making the student a surgeon. Roentgenology, especially diagnosis, is rapidly becoming a fundamental in medicine and is emerging from the status of a limited specialty. A great deal more time can be devoted to roentgen diagnosis without attempting to make the student a roentgenologist. Evidently this fact is appreciated by the young graduates.

The manufacturers of roentgen apparatus are constantly making machines safer and almost automatic and the sales of roentgen machines among general medical men are constantly growing, especially where there is no roentgenologist within easy reach. While it may be true to a certain extent, as Bass points out, that the country practitioner does not have need of a more extensive knowledge of roentgen diagnosis, yet in the future a broader acquaintance will be necessary as a part of a well-rounded medical education.

(C) *Type of Instruction.* Sixty-two of the graduates answering the questionnaire were dissatisfied with the type of instruction. They felt that the formal lecture was too theoretical and not sufficiently practical. They asked for more section work with demonstration of a large number of roentgenograms showing the various pathological processes. It was their opinion that this was of special value in connection with the study of the case history and the patient. This is best summarized in one reply: "Give us more section work, demonstrate radiographs in connection with the study of the patient as a whole." In order to do this there must be close cooperation with the various clinical departments.

Several stated that the dangers of roentgen diagnosis and therapy had not been sufficiently emphasized. This is inexcusable but perhaps understandable when we realize that these men received their instruction in roentgen therapy from a clinical department.

Constructing an ideal course in roentgen diagnosis and therapy for undergraduates from the suggestions received, we would

predicate a department of radiology or roentgenology under the direction of a full professor of radiology or roentgenology who devotes full time to his subject, and he should have such assistants as the volume of teaching warrants. The instruction should be given in four years, the last being elective, as follows:

First Year. Demonstration of normal anatomy given in conjunction with the department of anatomy.

Second Year. Demonstrations in small sections of roentgenograms of the common pathological processes.

Third Year. (*a*) Combined clinics with various clinical departments. In these clinics the roentgenogram is to be demonstrated by a roentgenologist, following the clinical study of the patient. (*b*) Didactic lectures, emphasizing the scope and limitations of roentgen diagnosis and therapy, its possible dangers, etc. The amount of theory taught is to be kept at a minimum.

Fourth Year. Elective. Attendance at formal interpretation, routine roentgenoscopy and such other work as particularly interests the student.

CONCLUSIONS

1. The ability of the instructors in roentgenology, as a whole, in Class "A" medical schools of the United States is good.

2. The type of instruction is not entirely satisfactory.

3. Too little time is allowed for the subject.

4. There is an unusual interest in roentgenology among the medical students.

5. An ideal course is outlined from answers received from graduates.

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POLYP OF THE DUODENUM

CASE REPORT*

By ROBERT J. REEVES, M.D., *and* ROSS GOLDEN, M.D.
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BENIGN tumors of the duodenum are not common. A review of the literature published in a recent article by one of us,[1] disclosed only 17 reported cases to which 2 more were added. This probably gives a false impression of their frequency. In his "Lehrbuch der Pathologischen Anatomie," published in 1861, although no specific cases are presented, von Rokitanski gives the impression of being familiar with them. Undoubtedly other instances of incidental findings at necropsy are hidden in the files of numerous hospital departments of pathology. For example, at this institution the cross index files of the Department of Pathology show 4 such unreported cases in which small polypoid growths were accidentally found in the duodenal bulb at necropsy. They are apparently being detected more frequently on roentgen examinations of the gastrointestinal tract and in some cases are of clinical importance.

It seems worth while to report another case in which there were a number of interesting associated conditions.

CASE REPORT

J. R. (Unit No. 68260), a doorman, aged sixty, of Irish descent, came to the Presbyterian Hospital, March 9, 1927, complaining of pain in the upper abdomen, very severe for the previous four days. For twenty years he had been having epigastric pain, extending over the entire upper abdomen, and at times radiating to the spine. The pain usually came on immediately after meals, and was relieved by sodium bicarbonate. For ten years the pain had been more constant, and for two years prior to admission he had nausea and spontaneous vomiting once a day, usually at night. He had

FIG. 1. Film showing the apparently normal contour of the stomach and duodenum. The polyp produces a rounded area of diminished density.

FIG. 2. The duodenal bulb partially filled shows the "vacuole" in the barium shadow much more distinctly.

* From the Roentgen-Ray Department of the Presbyterian Hospital, New York City.

taken alkalies with some relief. He had lost about 16 pounds during the previous two years. There was no history of hematemesis or clay colored stools. A roentgen examination at another hospital was said to have shown a duodenal ulcer.

The physical examination disclosed nothing of importance except a generalized psoriasis. There was vague epigastric tenderness. A test meal showed free hydrochloric acid to be 50, and total acidity 110. The guaiac test was negative.

Roentgen examination of the gastrointestinal tract, March 21, 1927, showed the stomach to be rather high and hypertonic. The pyloric portion was very spastic and never filled completely. There was no six hour retention. Because of the pylorospasm the duodenal bulb was not filled. A re-examination after the administration of atropine was requested. His condition improved, however, and he was discharged against advice to the out-patient department. Shortly after leaving the hospital he began having cramps in his legs after walking one or two blocks.

Re-examination of the stomach, March 31, showed considerable spasm of the pylorus. There was no six hour retention. The duodenal bulb appeared smooth in contour. There was a rounded area of diminished density in it which suggested a polyp.

He returned to the out-patient department August 25, complaining of continuous upper abdominal pain which was not severe enough to disturb his sleep and which had no relation to meals. He was placed on ulcer regimen for ten days and the pain disappeared.

Roentgen examination of the stomach was repeated on September 29, and pylorospasm was again noted. There was a very small six hour retention at this time. In the smooth, regular, non-tender duodenal bulb, the small, rounded, filling defect was again demonstrated.

A cholecystogram was made and demonstrated the presence of gallstones. Surgery was advised, but the patient would not consent. He improved and went home.

He was admitted to the hospital again on January 28, 1929, with a temperature of 103° and pulse of 120. Two weeks prior to admission he developed a bronchopneumonia. He complained of a sore mouth of one month duration. The mouth and throat appeared very red and numerous small ulcerated areas were present. A diagnosis of agranulocytic angina was made.

The blood examination was as follows: Hemoglobin, 87 per cent; red blood cells, 4,500,000; white blood cells 2,500. The differential count was: Polymorphonuclear leucocytes, 0; lymphocytes, 74 per cent; eosinophiles 24 per cent; basophiles, 0; endothelial cells, 24 per cent; lymphoblasts, 4 per cent. A large amount of débris was present, probably the destroyed white cells.

He continued to run a fever of 102° to 104° and appeared very drowsy and toxic. Neither the mouth nor the blood picture showed any improvement. On the second day a transfusion of 700 c.c. of blood was given, and a smear taken twelve hours later showed no polymorphonuclear leucocytes. The third day 0.3 gm. guanine hydrochloride in 40 c.c. of water (pH 4.0–6.0) was given. Six hours later the white blood cells were 1500, but there was only one polymorphonuclear leucocyte seen. The fourth day two doses of 0.4 gm. guanine hydrochloride were given intravenously. The following day the white count was 2000, with 12 per cent polymorphonuclear leucocytes. Another smear taken twelve hours later, however, showed the polymorphonuclears to be absent. Patient became comatose and died on February 1.

Necropsy disclosed a thin-walled gall-bladder containing watery fluid bile and a number of small calcium stones. The duodenum showed an ulcerated area in the upper margin of the bulb where the mucosa and submucosa were absent. The lesion measured about 1.5 cm. in diameter. The margins of this area were slightly undermined and showed no evidence of healing or deformity. On the opposite surface were several polypi, the largest measuring 0.5 cm. in diameter. They had the appearance of adenomatous hyperplasia of the mucosa. In the stomach was a small area which had the appearance of a healed ulcer. The submucosa was absent over this area and the mucosa was quite thin. The fibers of the muscularis were intermingled with many dense bands of collagen. At the margin of the old ulcer was a thick-walled artery.

Microscopical examination of the largest nodule showed it to be a small polypoid adenoma composed of Brunner's glands. It was covered by mucosa. The muscularis did not enter the tumor.

COMMENT

The vague symptoms which this patient had were more confusing because of the coexisting cholecystitis and the evidence of a healed gastric ulcer. The largest polyp produced an area of diminished density in the barium shadow of the bulb which could be easily demonstrated. At the time of the roentgen examinations, no evidence of a duodenal ulcer could be detected. In view of the character of the terminal condition, the question may be raised as to whether the ulcer did not develop after the last gastrointestinal study. The vague gastric symptoms in this case can hardly be attributed with certainty to the polyp alone.

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RADIUM AS A PALLIATIVE AGENT*

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SO MUCH prominence is given to the unusual and phenomenal cures which are occasionally obtained by radium treatment that one is apt to lose sight of the many hopeless cases which daily present themselves. These cases are entitled to just as much care and consideration, and just as much effort should be spent on them as on the cases which offer a chance for cure. If we can add an extra year of life to these unfortunates and make their last days more comfortable; if we can give them a little encouragement and relief by a treatment which offers some hope, however meager, then that treatment is well worth while.

With our present knowledge of the treatment of malignancy, the majority of sufferers from this disease suitable for radium treatment are incurable at the time they first present themselves, if we except cases of epithelioma of the skin. If this is true, palliative treatment is of prime importance since it involves the majority of cases seen. An analysis of the last 350 cases treated by radium in my private practice, not including cases still under treatment, shows an astonishing preponderance of incurable cases. In a total of 226 cases of malignancy, the results were favorable in 67; unfavorable in 159. If the experience of the average radiologist is similar to my own, he is called upon to treat about two and one-half times as many incurable cases as he is those in which he can hope for a recovery. I realize that it is not always possible to decide when a case is first seen whether that case is curable or not. In fact, it is frequently impossible. However, a correct estimation of the curability of a case is not often vital to the correct conduct of the treatment. That is to say, the treatment which would be proper to apply where one expected a cure, in a majority of instances would be equally applicable in an incurable case. There may be a few exceptions to this rule, but unless the case is beyond all question obviously hopeless, the best policy is to treat all patients as if a cure were expected. If this policy is followed, one will occasionally be agreeably surprised to see an apparently hopeless case recover. One of the most certain things we know about malignancy is that it is impossible to predict the progress of a case. With this in mind, it has been my experience that the best way to achieve palliation is to disregard what we are accustomed to think of as palliative treatment and treat the patient as if a cure were expected. The few instances where this plan is unwise will be discussed specifically later.

The object of this paper is to describe the general plan of treatment which I have found most efficacious in incurable cases of malignancy of various types and which is also capable of bringing about a cure if an error has been made in estimating the curability of the case. Any system of palliative treatment which does not admit of the latter possibility is, it seems to me, open to criticism. I refer specifically to inadequate dosage applied in such a manner and at such intervals that a curative effect would be impossible. Such treatment will not have any better palliative effect than doses of sufficient size applied at proper intervals to cause destruction of malignant tissue. There are very few patients indeed whose physical condition will not permit adequate treatment judiciously administered. There are, of course, certain types of malignancy which are very resistant to radiation, and often there is no way to determine this fact before treatment. Biopsy may give some informa-

* Read at the Fourteenth Annual Meeting, American Radium Society ,Portland, Oregon, July 8–9, 1929.

tion on this point and for this reason, as well as from the standpoint of useful statistics, is very desirable. However, there is no doubt that biopsy may increase the likelihood of metastasis. If it can be shown that the patient has a type of malignancy well known to be highly radioresistant, the indication for more active treatment in order to achieve palliation is obvious. However, if the general plan of always treating as vigorously as possible is followed, this end will be attained. It is believed by some that repeated small doses of radiation bring about fibrosis in a tumor and that no small part of the improvement which may be noted is really due to this fibrosis. It is probably true that the amount of fibrosis occurring in tissues after irradiation is in direct proportion to the amount of destruction of radiosensitive cells. Personally, I doubt if radiation ever *actually stimulates* the production of fibrous tissue, but believe rather that the fibrous tissue is formed to replace other cells which have been destroyed. If this is true, our primary object either for palliation or cure, is the destruction of malignant tissue. Our aim then should always be to destroy as much malignant tissue as possible, always keeping in mind the effect of such destruction on surrounding normal structures and on the patient's economy as a whole. There is nothing gained in applying treatment which destroys the disease but kills the patient.

Consideration will now be given to the general plan of treatment which I have found to be most efficacious in apparently incurable cases of malignancy of various types and locations.

Carcinoma of the Mouth. The location of the lesion has a significant bearing on the prognosis in this type of malignancy. Lesions on the gums, or inside of the cheek have a very fair chance of recovery if they are not extremely advanced, or the bone is not involved. Lesions of the floor of the mouth usually do well if the tongue is not involved; those on the hard palate are more serious, but there is still a fair chance of a cure if the bone is not involved. Lesions in all these locations should be treated with massive doses in the expectation of obtaining a cure. The chances of bringing about this result are great enough to overbalance any risk of adding to the patient's misery by subjecting him to the reaction which accompanies such treatment. This discomfort will be less if the lesion can be treated by surface application instead of interstitial irradiation with radon seeds. The latter are especially contraindicated if the lesion is very close to bone. By the exercise of a little ingenuity there will be few lesions in the locations under consideration which cannot be reached by surface application. Gamma radiation is undoubtedly preferable for this treatment. I use radium element in platinum needles with an extra filter of 1 mm. of brass and 2 mm. of soft rubber. As to dosage, the radium is distributed in 25 mg. units, enough of these being used to cover the lesion, and at the initial treatment they are left in position for fifteen hours. The distance from the center of the radium capsule to the surface of the lesion is about 3/16 of an inch. This dose is an escharotic one and if the case is curable will destroy the lesion, provided it has been in accurate contact for the full length of the treatment. If the lesion does not disappear with the subsidence of the radium reaction, the case is probably not curable and it is doubtful if it will be benefited by further radium treatment, unless there are areas in the lesion which did not receive a full dose. If a careful examination of the lesion seems to indicate the latter possibility, the treatment may be repeated in a similar manner. This technique offers a fair chance of a cure in a good percentage of cases; and in those which are hopeless, as much alleviation will be obtained as by the use of milder doses. As a matter of fact, I have never been able to see any

benefit from the use of suberythema doses frequently repeated, or from the use of beta radiation, obtained by using much less filtration for correspondingly shorter periods of time.

Carcinoma of the Tongue. These cases are always a serious problem. If there appears to be any hope of a cure at all, interstitial irradiation with gold or platinum radon seeds offers the best chance of recovery. The technique of this treatment requires no description at this time. If the case is too far advanced to warrant this form of treatment, contact application may be tried, although it offers little in the way of palliation. I have treated a few cases with external application of deep roentgen therapy and radium, with considerable relief of pain, but without appreciable effect upon the progress of the disease. The saturation method as advocated by Pfahler is particularly appropriate for this class of cases.

Carcinoma of the Tonsil and Adjacent Structures. Radium needles, or gold or platinum radon seeds are undoubtedly superior for treatment in this location. They offer practically the only hope of a cure and if this is not effected do not add too much to the patient's discomfort if properly employed. I have a few patients with malignancy in this location which were seemingly entirely hopeless and which were treated in this manner with surprising results. Three of these are entirely well for more than five years.

Carcinoma of the Lip. While I prefer low voltage unfiltered roentgen radiation for these lesions, I occasionally employ radium, using the same technique as described for lesions inside the cheek. I am opposed to interstitial irradiation in this location, believing it to be unnecessary and adding an extra hazard of infection and sloughing which does not pertain to surface applications.

Cervical Metastases Accompanying Oral Malignancy. In a large percentage of these cases, treatment will be only palliative. Interstitial irradiation is advocated by some in treating cervical glands, but in my hands it has not been very satisfactory. Probably in selected cases it has a field of usefulness. The question of operative removal is one which arouses considerable dispute, but for our purpose may be disregarded, as the radiation treatment should be carried out in the same way whether the patient has been operated upon or not; that is, the patient should have as much radiation as it is possible to administer with safety, either with radium or high voltage roentgen rays. For this treatment the saturation method of Pfahler is very useful. In applying this method with radium, the same rate of loss may be calculated as for high voltage roentgen rays.

Carcinoma of the parotid gland, carcinoma of the antrum, and sarcoma of the bones of the face should be treated in a similar manner to cervical metastases.

Carcinoma of the Larynx. These cases are practically all hopeless and in using radium for palliation, great care must be taken not to overdose as the reaction which follows is apt to cause enough swelling to entirely close up the larynx. It is impossible to predict what dose may be safe in a given case. I have always felt that it was rather dangerous to give more than one-half a skin erythema dose applied to each side of the larynx. In a recent case, however, the use of one-third of an erythema dose applied to one side of the larynx resulted in so much edema of the laryngeal tissues that tracheotomy had to be resorted to. It would seem improbable that smaller doses than this would have any beneficial effect. If so, the treatment can hardly be undertaken without some risk. I have not noticed the same tendency toward edema following high voltage roentgen therapy, but this may be merely coincidence. Theoretically, there should be no difference in these two agents in this respect.

Carcinoma of the Genitourinary Tract—Prostate. Radiation therapy can hardly

be considered other than palliative in this affection. I have been in the habit of treating this organ by three procedures: (1) radium introduced on a urethral sound, 50 mg. being used, well filtered and left in place for two hours; (2) radium introduced into the rectum on a soft rubber bougie in such a manner that the radium comes in contact with the prostate. By rotating the bougie, different areas on the prostate are exposed, three being the usual number, although where the prostate is very large, one or two more areas may be available. Each area is exposed three hours using 50 mg. well filtered; (3) cross-firing of the pelvis externally using high voltage roentgen rays. By this combined treatment considerable palliation can usually be obtained.

Bladder. Large doses of radium in the bladder are usually disastrous. In small circumscribed lesions, local treatment may be carried out through the cystoscope either by holding radium in contact with the lesion, or by imbedding radon seeds. The latter procedure, however, must be carried out with a full knowledge of the effect which will follow and is essentially the work of a trained specialist. At the present time, my efforts to attain palliation in cancer of the bladder are limited to the use of high voltage roentgen rays applied externally to the pelvis.

Penis. Probably the best results will be obtained in this condition if radiation is applied with the definite idea that it is only palliative and is to be followed by operation. The only cases that I have living have been treated in this manner. These lesions are extremely resistant to radiation and require large doses to produce any visible effect. I have been in the habit of applying a full erythema dose of filtered radiation at weekly intervals for three or four treatments, after which amputation may be performed.

Uterus. Lesions of the fundus are essentially surgical. If for any reason they are inoperable, radium may give considerable relief. It must, of course, be introduced into the uterine canal. I have been in the habit of using 50 mg. for this purpose, leaving it in place for forty-eight hours. This treatment should be supplemented by high voltage roentgen rays applied externally.

Carcinoma of the cervix is often curable by radium treatment alone. If this seems probable, doses sufficient to destroy the lesion must, of course, be used. So much has been written describing this procedure that I do not feel justified in going into details regarding it here. However, if the involvement is such that a cure seems impossible, care must be taken that our palliative treatment does not make the patient worse instead of better. This is especially true where the involvement extends in such a manner that destruction of the lesion is apt to result in a fistula into the bladder or rectum. Under such circumstances, I have obtained the best results by applying about one-half of the usual 2500 to 3000 mg-hr. dose, and repeating this treatment once or twice at intervals of four to six weeks. This seems to me a better technique than building up to the usual dose by weekly or bi-weekly treatments. I have two reasons for this belief: (1) The cancer cells are subjected to a larger dose when they are most vulnerable, that is, at the initial treatment; (2) the tissues have more chance to recover between treatments, giving time for the production of fibrous tissue. There should, therefore, be less danger of fistula. Here also, high voltage roentgen rays applied externally are useful, especially if there is extension into the broad ligaments.

Carcinoma of Rectum. Probably the greatest palliative measure in this condition is the institution of a colostomy. Having done this, if it is decided that the remaining treatment can be only palliative, contact applications of radium may give a great deal of relief, although the chances of a cure by this method are very small.

The rectum is very sensitive to radiation and overdosage may result in very distressing sequelae to the patient, both in the way of discomfort from the reaction, and permanent disability from the stricture which may result. For this reason the radium should be well filtered with brass and a reasonably thick secondary filter is also advisable. The usual dose that I employ is 50 mg. for nine or ten hours. This dose may be repeated every four to six weeks for three or four treatments. High voltage roentgen rays applied externally are also useful to supplement this treatment.*

* For discussion see page 535.

OPEN SURGERY AS AN AID TO EFFICIENT POSTOPERATIVE RADIOTHERAPY*

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WE NEED not quote statistics here to show the frequency of recurrence of cancer, since these are repeated in nearly every paper written on the subject. We know that about 75 out of every 100 patients treated for cancer die within five years and the remaining 25 who survive belong either to the less malignant type or were treated in the early stages. A great majority of deaths are due to recurrence. If it were not for recurrence, cancer might be classed as a curable disease. A temporary cure for carcinoma is indeed an easy matter. In fact, nearly every patient operated upon is, so to speak, cured until recurrence takes place. Therefore, if we are to improve upon these lamentable results in cancer therapy, we must direct our efforts to the prevention of recurrence, and it is to this phase of the subject that I wish to call attention.

Of all the methods used in cancer therapy, only two have stood the test of time; these are surgery and radiotherapy. All other methods have been practically abandoned. Injections of colloidal metals, such as lead, and various serums, have not been sufficiently tested to warrant their general use, and thus their discussion will be omitted. Balance of London recently stated that the consensus of opinion of authorities at the last International Conference in London was that surgery of cancer at present is efficient but that operation combined with radiotherapy is certain to be more valuable. It is then to surgery plus radiotherapy that we have to look for results. It seems, however, that we are not getting the utmost that can be obtained with these two agents. If I were asked to state the main cause of our failure in cancer therapy I would say that it lies in the lack of cooperation between the surgeon and the radiologist. Surgery has about reached its limits in cancer therapy. We must therefore look for improvement elsewhere. Is it then inefficient radiotherapy? I reply that it is. By this I do not mean that the radiologists are not competent. They are highly efficient, but they are handicapped because the surgeons as a rule are not sufficiently familiar with the physical laws of radiation and its action on normal and malignant cells to estimate in what conditions the radiation would be effective or in which cases it would be useless or even harmful. Surgeons can be very helpful to the radiologist by preparing the field for irradiation so that the work may become fruitful. Of course, we cannot expect every physician to be an expert radiologist, but he should know enough about the work upon which the success or failure depends so that he can consult with the radiologist upon the indications in each case.

We shall briefly review the essential points with which the surgeon and physician must be acquainted. Both must study the biological and anatomical differences between the cancer and the normal cells of the body and their response to radiotherapy, in order to apply the treatment with scientific precision.

It is the usual practice of scientific physicians when attempting to cure a disease to first try to find its cause. In this requirement we have utterly failed. Nevertheless, in the search for the cause we have discovered many facts which are useful in the treatment. We know that heredity plays a part in the genesis of carcinoma. This has been proved to be so, at least in the case of animals (Sly). Blumenthal of Berlin refutes the hereditary theory. Carcinoma, he states, may be produced by

* Read at the Fourteenth Annual Meeting, American Radium Society, Portland, Oregon, July 8–9, 1929.

injection of tar into the ear of a rabbit, an organ in which it never appears spontaneously, and that carcinoma can be produced at will by irritating substances and parasites. He admits that not all parasites produce cancer, but many varieties do,—such as Bilharzia, the Cysticercus and spiroptera, which latter produces it in rats. He lays stress upon the fact that carcinoma is not a general disease and that it always starts locally. This is fortunate, for if it were a general disease to start with, it would be nonsense to try to cure it by operation, for the local removal would never prove successful.

Roussy of Paris enumerates three theories for the causation of cancer:

1. Microbic theory—not conclusive.

2. The embryonic or Cohnheim theory, which he regards as possible.

3. Acquired character cell theory, which he believes to be certain. Virchow was the first to advance the acquired cell theory and claimed that the change in the cell was due to chronic irritation or inflammation and loss of equilibrium.

Menetrier also speaks of the functional differentiation due to chronic irritation, and claims that cells reproducing themselves under such abnormal conditions acquire new properties of function and assume the character of a lower type organism, such as Infusoria, being able to exist without cooperation with the general organs, and thus they form tumors. But this theory does not conform with the Darwinian theory, "The survival of the fittest." It would mean that the carcinoma cell is the most fit to survive. Ewing doubts that a mature cell may retrace its steps and acquire an embryonic character. He does not emphasize heredity as a predisposing factor although he admits that in animals it has been proved.

The cancer cell is as yet histologically not distinguishable from the normal epithelial cell. It is quite possible that in the future we may be able to distinguish a single cancer cell from a normal one. With the instruments at our command we are not able to do so because of inefficient magnification with our microscopes. At present I am engaged in the solution of this problem by a method of stereoscopic microphotography. With the aid of these stereo-microphotographs we are able to distinguish certain minute differences in the structure of cells not visible in the single flat image. When the work is completed it will be treated in a special article.

In viewing these microphotographs it is possible to visualize each cell in its respective depth of the section, and its relation to its neighboring cell. More than that, you can estimate the position of each nucleus and at times also the nucleolus and study the fine reticular structure of the transparent protoplasm of the cell body. This method of studying the microscopic sections is of course also applicable in other diseases than cancer. Our experiments are being extended to the study of fungi such as actinomyces and micro-organisms such as gonococci and tubercle bacilli.

Biologically, the cancer cell behaves quite differently from the normal cell. It reproduces more rapidly, grows faster and dies more readily. It is not a new type of cell foreign to the human body, such as a parasitic organism introduced from the outside. It is a product of the human body itself. It is an offspring, a child, so to speak, of the normal cell; but it has changed its biological characteristics. It lacks the stability and resistance of the normal cell and therefore it is more easily destroyed. This in a measure explains why radiation destroys the cancer cells more readily than it does the normal.

Now we ask ourselves, "If radium destroys the cancer cells, why does it not destroy the normal?" It does destroy the normal, providing the dosage is large enough. With proper discrimination of dosage, screening, and time of exposure, the cancer cells will perish while the normal cells will be only slightly, or not at all,

injured. This is due to the greater resistance of the normal cell. The susceptibility of pathological cells to radiation varies. Some types, such as sarcoma and lymphoma, succumb to smaller dosage than scirrhous carcinoma or endothelioma. Upon this essential difference depends, in a large measure, the success of radiotherapy of any particular case.

With these principles clearly in our minds, we should have no difficulty in estimating the dose that will destroy the cancer cell and at the same time spare the normal. But in trying to apply this important principle, the radiologist is handicapped. He is unable to deliver into the depth sufficient radiation without the risk of injury to the overlying structures, such as the skin, muscle, etc., which cover the deeply seated retained cancer cells.

How can the surgeon help out in this dilemma? He must plan and perform the operation in such manner as to make the application of radiation most effective, and this is accomplished by leaving the wound open.

First of all, he must remove the entire growth whenever it is possible. In other words, the most radical operation must be performed. But no matter how radical and complete the operation and how skillful the surgeon, he cannot be certain that every vestige of the growth has been removed, because the remnant may be so small that it is not palpable nor visible to the naked eye. Since every retained cancer cell remaining in the operative field and buried in the depths is a potential recurrent tumor, is it a wonder that recurrence is so frequent? Not until the last cancer cell is destroyed, can we expect a lasting result.

How can we get rid of the last cancer cell? This problem is not so difficult as it appears, providing the surgeon cooperates with the radiologist. The closure of the wound after operation locks up retained cancer cells, covering them with skin, muscles, etc., which interferes greatly with efficient radiotherapy. The dosage then required in order to reach the deeply retained cell would have to be so large as to make employment dangerous to the skin and overlying structures. To guard against burns, the radiologist must protect the skin by interposing heavy filters and this interferes with the penetration of the rays into the depths. Thus the most effective rays are absorbed by these filters and the dosage of the rays which pass through the filters may become so small as to have the opposite effect of stimulating the growth, instead of destroying it.

This factor in the application of the rays has led to the criticism against the usefulness of radiation, and the bad results have been charged to radiotherapy when they should have been charged to deficiency of knowledge of the laws of radiotherapy. As long as the application of radiation is left to chance, results will be poor and the method discredited.

To overcome this difficulty, I introduced the method of open surgery some fifteen years ago and have published a number of reports. The first article appeared in 1919.* It consists, as you know, in the radical removal of the growth or as much of it as is feasible, but instead of closing the wound, it is left entirely open, no matter how large the wound may be. Through this open wound the radiologist is able to deliver the correct dosage for the destruction of any cancer cell which may have been left during the operation, without the risk of burns.

This procedure will serve a double purpose:

(*a*) The radiologist will be able to implant either radium directly into the cancer field, or if he applies roentgen rays, to deliver into this open space sufficient radiation without fear of overdosage to the

* Beck, E. G. Intentional removal of skin and other tissues overlying deep-seated inoperable cancer, a necessity for effective treatment with x-ray or radium. *Surg., Gynec. & Obst.*, 1919, *29*, 325.

surrounding tissues, because the dosage then required is many times smaller than it would be if the wound were closed;
(*b*) Radio-toxemia is prevented because the débris resulting from the breaking down of the cancer is not absorbed into the circulation. It is eliminated through the open wound.

The treatment thus outlined has, like all other methods, some disadvantages. First, it takes longer for the open wound to heal. At times it requires two or three months, depending upon its size. It is closed gradually by regeneration of skin from the wound edges by applying adhesive strips to the edge of the wound (a method which I described some years ago in the treatment of burns). It is surprising how quickly regeneration of skin thus takes place. The gradual contraction of the wound also shortens the time of closure. I wish here to mention an observation I have made, namely, that normal skin will never grow on an area where cancer tissue is still present. When the skin has regenerated over the entire denuded surface, we may be certain there are no cancer cells immediately beneath the skin.

The second disadvantage lies in the frequency of dressing. The wounds must be dressed every day. This is a tedious job, although it is not painful, nor is the odor of the discharge, as a rule, disagreeable.

It is surprising how seldom troublesome infection takes place. In not a single case of my own was it serious, the temperature rarely exceeding 102° F. I consider mild infection really an advantage, since it is likely to destroy some of the remaining cancer cells. This is, in my opinion, an additional important factor in cancer sterilization by open wound treatment. These disadvantages, if we may call them such, are minor objections and are greatly overbalanced by the good results obtained. The patient is sufficiently rewarded for the added time, trouble and expense.

I have employed this open method of treatment in practically all of my carcinoma cases during the past fifteen years. Fifteen years ought to be sufficient time for us to draw some practical conclusions as to its utility.

I am pleased to report at this time that the actual results from this open method treatment have justified its employment since we have therewith reduced recurrence to a small percentage, especially in breast cases. Since 1916, in only two cases of a series of 16 cases, all of which were primarily operated with the open method, the recurrence was not in the primary seat, but was metastatic.

Quite different were the results in cases which we saw after the recurrence had taken place, all of which had been treated elsewhere with closure of the wound. In not a single one of 26 cases did a patient survive the fifth year, and usually death took place within a year from recurrence.

This further convinced me that in the success of the first operation lies the fate of the patient.

The results from the open method employed in other parts of the body, such as extensive carcinoma of the lip and neck, are equally favorable. We have in our series of 41 lip and neck cases, 3 cases in which a cure would hardly have been expected. These three were operated on with the open method in 1918, 1919 and 1922, respectively, and in none of them has recurrence thus far appeared.

Compilation of comparative statistics has been deferred.

DISCUSSION ON PAPERS OF DRS. GRIER AND BECK

Dr. L. R. Sante, St. Louis, Mo. Dr. Grier made one statement with which I do not agree. When a case is absolutely hopeless, as evidenced by extensive involvement of some vital organ, or metastases, it should not be treated with the same severity as a more hopeful case. For instance, if there is lung involvement or secondary bone involvement, it seems to me we can keep the patient much more comfortable by employing smaller doses than would be used if a cure was expected.

Dr. Beck's unique method of demonstrating cell structure by the stereoscopic effect produced is the same as that obtained on viewing the original slide through a binocular microscope. When magnified, it seems to me all we see in the stereoscopic view is the deeper cell, and how this will aid us more than the binocular microscope in determining the actual malignancy, I do not understand.

I would like to mention something we have contemplated in an endeavor to show the actual malignant change that occurs in the tissue in reference to the normal cell. We all know that the refraction of an x-ray beam as it strikes the various planes of a crystal will form definite patterns on a roentgen film. These patterns can be analyzed and the character of the substance which produced them can be determined by physicists. The structure of very fine substances can be analyzed in this way; for instance, a fiber strand from a spider's web. It has occurred to us that by this means we might determine the structure of cells. Would there be any variation in the patterns produced by cancer tissue, and the normal body tissues, the cutaneous tissue, and so on? To that end we have endeavored recently to make some patterns of these structures. Two samples of steel, for instance, will show no difference whatever microscopically, and yet they have a wide variation in the molecular pattern.

Dr. Beck has advocated the open method of treating carcinoma for a long time, and I have seen some striking examples of its effectiveness in the work of our own surgeons. I recall a sarcoma the size of a small football that sprang from the scapula, which did not show bone structure in the specimen. It was removed and there was no impression in anyone's mind that the growth had been more than superficially removed. The wound was left wide open and radium applied. Healing was complete and the patient is well for almost two years now. I believe that getting rid of a large amount of the growth may have some influence in preventing metastases. Just how this would influence metastasis, I do not know, but from several cases we have had I have been led to that belief. In one case, the patient had a large mass in her neck, which she said had appeared within two months. The question was should we section this growth. We were afraid to do this and advised a full dose of radiation and then within twenty-four hours or so before microscopic changes could take place, to take a section. Through some error, the section was not taken for five days and then the tumor had disappeared. About one month later she developed two abdominal masses, which proved to be lymphosarcoma, to which she succumbed.

In another case within ten days after treatment for sarcoma of the thyroid, the growth regressed but metastasis developed in the breast. About 40 per cent of the usual dose was applied over that and it also regressed, but she developed another lesion in the abdomen. I wonder if the rapid regression and absorption of the tumor material that is left behind had anything to do with the appearance of the tumors so promptly elsewhere in the body. Would it not be better to remove as much as possible of these growths and leave the wound open, treating the remaining tumor tissue with radium?

Dr. George E. Pfahler, Philadelphia. First of all, I wish to answer the question just asked by Dr. Sante. In dealing with lymphosarcoma it is not the primary growth that concerns us most but the extension, and I think when dealing with lymphosarcoma, lymphatic leucemia, and Hodgkin's disease, all of which may be classed as lymphoblastomas, it is the metastases all through the body that give us concern. Dr. Sante spoke of a small dose causing disappearance of the tumor. I had a boy with three-fourths of his chest filled with tumor masses, in addition to enlarged glands in the neck, and this was one of the cases that formerly was supposed to be cervical tuberculosis, but microscopic examination showed only inflammatory tissue, according to the pathologist. A later biopsy showed lymphosarcoma; my diagnosis clinically was Hodgkin's disease and ultimately the patient died of lymphatic leucemia, but I gave that boy a 15 per cent dose and the entire tumor almost disappeared. Before I could give him more treatment, he developed glands all over the body typical of lymphatic leucemia, and died. Therefore, I think that when we treat those cases that we can recognize as belonging to the group of lymphoblastomas we should not only treat them, but cover the entire lymphatic system, beginning with small doses, perhaps 5 per cent,

especially in a child, and perhaps give daily treatments, going up with the dosage slowly and being careful not to knock the patient out.

Dr. Grier has given us an excellent paper on palliative treatment. I frequently have doctors say, "What is the use of treating the patient by palliation if it is only a matter of prolonging life?" I ask them what they do for any of their patients except prolong life. I think it is our duty to treat these patients insofar as we can do so, and make them more comfortable while they are alive. If they are not made more comfortable, I question whether it is worth while, unless for some ulterior motive.

Carcinoma of the larynx was mentioned by Dr. Grier. I have been interested in this condition for a long time. I have had some serious cases of edema of the larynx and breaking down of the thyroid cartilage in my earlier experience, but beginning three years ago, and particularly during the last year, I have treated about a dozen cases of carcinoma of the larynx at the request of Dr. Chevalier Jackson, all of which had been found inoperable. I have given as high as 50,000 mg-hr. and we have not had obstructive symptoms of edema in any of these cases. They have all been advanced cases and they have all shown improvement. Just before I left home last week, Dr. Tucker reported that in one case the growth had disappeared so far as he could see. We have had no damage occur to either the skin or the cartilage in using highly filtered gamma rays in the pack. I think we can save a lot of tissue, do a lot more work, and accomplish results we have not accomplished before, by increasing the filtration, which necessarily increases the period of time during which we must irradiate.

Dr. Beck's work has always appealed to me and about fifteen years ago, I was primarily interested by the work of Dr. Otto H. Foerster, who treated a series of breast cases after open exposure. I followed with a series of cases, I think 10 or 15. We did not get any local recurrence, but in my experience we rarely ever do get local recurrence. It is the metastases that bother us and I do not see how the open wound will help us to control the metastases. We will control them only so far as our irradiation goes beyond the wound, and most men will not have enough patience to take care of the dressings necessary over a long period of time.

Dr. Beck (closing). I do not claim to have succeeded in showing the difference between the cancer cell and the normal cell, but I do claim that in the solution of this problem stereomicrophotography may be a great factor. Some trained pathologist may discern the difference by this method. What I am trying to do is to improve on the method of detecting the differences. A fixed specimen does not show the real structure of the cell. The cell being dead and practically dried up, differs in structure from that of a living cell. If we could stain living cells and keep them alive while examining them under the microscope, we could probably discover the difference between a cancer and a normal cell.

A tissue section represents, as a rule, about three or four layers of superimposed cells. In studying the slide, you really see three layers of cells in different depths, one in good focus and the others less distinct. It requires changing of focus in order to study each of the three layers separately. In the stereo plates, you are able to study all layers in one focus. Magnification reduces the clearness of the outline of the cell in the single picture, but in the stereoscopic one, the picture remains clear. I believe that with the assistance of the stereo-microphotographs we will be more apt to differentiate normal from cancer cells.

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EDITORIALS

THE MATHEMATICAL DISCOVERY OF THE X-RAYS

THE first to find the new planet beyond Neptune was C. W. Tombaugh at the Flagstaff Observatory, Arizona. But the world grants the chief honor of this discovery to a man who has been dead fourteen years. Percival Lowell discovered this planet mathematically, determined its mass and plotted its orbit from the perturbations of its nearest neighbor. But he himself never found it in the heavens. Tombaugh, in the same observatory, working with a more powerful instrument, searched the skies with photographic plates where Lowell's calculations had shown that another planet should be found—and found it. That Neptune had been discovered eighty-four years earlier by precisely the same process in no way detracts from Lowell's achievement, and emphasizes the care with which astronomers give honor where honor is due.

This mathematical discovery of a planet preceding its physical discovery has an extraordinary parallel in the discovery of the x-ray. Two years before Roentgen found and demonstrated these rays another physicist had discovered them mathematically, had specified their properties regarding reflection, refraction and the penetration of substances opaque to visible light, and had indicated their exact position in the spectrum beyond the ultraviolet. This was an achievement of intellect far outranking the calculations of the perturbation of a planet, great as that is. It involved the extension of a marvelous theory, a precision of mathematical deduction, a depth of learning and a mental grasp such as only a von Helmholtz could bring to bear. For Helmholtz it was who in 1893 published his Electro-Magnetic Dispersion Theory of the Spectrum and provided on purely mathematical grounds the exact space which we now know to be occupied by the roentgen rays. The final verification came in 1913 when Friedrich and Knipping under Laue's direction demonstrated on the photographic plate the nature and place of the x-ray in the spec trum.

We may properly ask why so remarkable an achievement in mathematical theory has not been more generally recognized. What is the difference between physics and astronomy? Has the public discredit of theories affected the scientific mind? Certainly it is with difficulty that any mention of Helmholtz can be found in works on the physics or history of the x-ray.

In the first book on the x-ray published in America, "The X-ray or Photography of the Invisible," by William J. Morton, M.D., we find an Appendix C giving a review of the Dispersion Theory of von Helmholtz. The original paper of Helmholtz is buried in Vol. XLVIII of Wiedmann's *Annalen*, which so far as we know has never been translated into English. Appendix C is a reprint of an article by Sir Oliver Lodge published in *The Electrician*, London, England, July 17, 1896, seven months after Roentgen's announcement and is the source of our information concerning the Helmholtz theory. Lodge is discussing the true nature of the newly discovered rays. In the course of this article, he says, "Taking all these things together and looking at them in the light of a notable dispersion theory of von Helmholtz to which Prof. J. J. Thomson called attention in the Rede Lecture at Cambridge this year (June 10), it becomes almost certain that the x-rays are simply an extraordinary extension of the

spectrum far beyond the ordinary ultraviolet."

Lodge then explains and discusses the Helmholtz dispersion theory in considerable detail and concludes with this remarkable paragraph:

"Such is a rough account of the theory prepared by the extraordinary genius of von Helmholtz, on purely mathematical and Maxwellian grounds, in 1893 before even the experiments of Lenard and indeed without any likelihood of an idea that the waves whose theoretical niche was thus provided, were so soon to be practically displayed in the laboratory as an accomplished fact."

This was written by Sir Oliver Lodge seventeen years before the demonstration by Friedrich and Knipping proved beyond question that x-rays were in truth "an extraordinary extension of the spectrum far beyond the ordinary ultraviolet." Here we find another example of theory preceding demonstration. Laue, professor of physics in Munich, theoretically identifying, knowingly or unknowingly, the x-rays of Roentgen with the short-wave lengths of Helmholtz at the extreme end of the spectrum, reasoned that refraction and reflection had not been demonstrated simply because no surface sufficiently smooth and no grating sufficiently fine had been used. To him the theoretical structure of crystals was as real as though he had seen it with the naked eye. He proposed, therefore, that the cleavage plane of certain crystals be used as a perfect reflecting surface when the rows of atoms would provide the lines of a grating of ultramicroscopic fineness. This was carried out by Friedrich and Knipping using a crystal of zinc-blend with the result that the x-ray spectrum was given to the world and that the x-ray ceased to be an unknown quantity.

Helmholtz's theory, or rather mathematical demonstration, was founded on Maxwell's electro-magnetic theory of light, and embraced the entire spectrum. Not only did it define and place x-rays, but it also provided for wireless or radio waves below the infra-red and described their power to pass through all ordinary barriers. Helmholtz was more than a mathematician and theorizer. Seven years before the publication of his theory he set one of his pupils, Hertz, at the problem of producing some of these invisible waves in his laboratory to prove Maxwell's conception. Hertz, as the world knows, demonstrated for the first time the wireless waves which have since been known as Hertzian waves. Their practical application by Marconi and De-Forest is another story. Lenard who of all preceding investigators most nearly anticipated Roentgen was in turn a pupil of Hertz. Thus was the torch handed down from the great physicist whose influence led directly to the discovery of wireless and to the brink of the x-ray.

Von Helmholtz long before the time of his Dispersion Theory, was easily the foremost scientist in Europe. His writings were voluminous and covered a wide range of subjects. He is best known among medical men for his invention of the ophthalmoscope. He started his career as a physician and surgeon but later turned to teaching, holding successively the chairs of anatomy and physiology in Berlin, Königsberg, Bonn, and Heidelberg. He became distinguished not only as a physiologist but even more as a mathematician and physicist, and in 1871 he returned to Berlin as a professor of physics. In 1888 he was made head of the Imperial Physico-Technical Institute at Charlottenburg. He had already been ennobled by the German emperor. His overwhelming reputation is vividly recounted by Pupin. In 1893, the date of the publication of his Dispersion Theory, he visited the United States, having been selected as honorary president of the International Congress of Electricians at the Columbian Exposition in Chicago. His death occurred in August, 1894, at Charlottenburg, a year and four months before the discovery of those

rays which he so marvelously predicted and described.

It was in this period after 1893 that both Lenard and Roentgen were carrying on their researches. The platino-barium cyanide screen which led to the discovery of the x-rays was the chief instrument for the detection of ultraviolet radiations; that is to say, radiations in general beyond the visible spectrum. This fact has been emphasized to show that Roentgen was investigating the presence of invisible rays and that, therefore, his discovery was not an accident. Could Roentgen, a professor of physics especially interested in the study of the spectrum, have been unaware of the publications of his great confrère, in his native language, on this special subject? We think it possible and probable. A careful reading of Roentgen's original paper announcing the discovery of these new rays contains not a word remotely suggestive of a dispersion theory and yet Roentgen speculates upon the nature of the rays and proposes the theory that they are longitudinal vibrations as distinguished from the transverse vibrations of visible light. It is true that within a year following Roentgen's announcement, two English scientists, Sir Oliver Lodge and Professor Thomson at Cambridge, in the light of the dispersion theory, came to the conclusion that Helmholtz was right and that the x-rays of Roentgen lay at the ultraviolet end of the spectrum. But this mathematical theory of Helmholtz was, like the relativity theory of Einstein, understandable only by a select few. Roentgen had no reputation as a great mathematician. He was an investigator, not a theorist. He worked with things rather than ideas. Certainly his lack of acquaintance or perhaps his undervaluation of the dispersion theory is less surprising than the silence of other physicists who followed him.

However, unless Sir Oliver Lodge and Sir J. J. Thomson are mistaken, it appears that to Helmholtz belongs the credit for the mathematical discovery of x-rays just as to Percival Lowell belongs the glory of the mathematical discovery of the new planet. The physical discovery of the planet was the direct outcome of the mathematical demonstration. The actual discovery of the x-rays was not the result of any mathematical theory but a triumph of the experimental method in pure physics. It is no detraction from Roentgen's discovery to recognize the achievement of Helmholtz and to honor him as the theoretical discoverer of the x-rays.

A. W. Crane

A RADIOLOGIST IN HIS GARDEN

"GOD planted a garden and there he put the man whom he had formed" That was the first present given to man, and to the man who can appreciate it, it is the noblest gift he can receive. Most radiologists are town bred and do not hear "the voice of the Lord God walking in the garden in the cool of the evening." Yet some of us who take a narrow view of life and specialize in short wave lengths, do have a broader view of life and when we lock the office door we shut out of our life one branch of nature and go back to the study of nature as a whole by retiring to our gardens. It is not only the beauty of nature that one learns in a garden. Plants are remarkably like our patients and the more we study plants the more resemblances we see. For instance, the abortion, the infant mortality, the puny adult and the hefty prize fighter can all be traced by planting a ten cent package of seeds. These seeds may all receive the same nourishment, light, air and heat yet one just germinates and dies like an abortion, another lot will grow and put out their cotyledons only to wither up and die—infant mortality. Others come to maturity but are always puny, while another lot will live, fight, stand harsh treatment, and

grow into fine plants. Why do they thus behave? Heredity is the only explanation. So when you have the narrow-chested, elderly spinster, with the dropped stomach and the low cecum, you are reminded of the puny plant that will not thrive no matter how you treat it. On the other hand, there are plants that will grow no matter how you treat them and they will all come to maturity and bear flowers at the same time, yet one is but six inches high, with only one flower, while its sister has grown into a bush six feet high with masses of huge bloom. The *Datura stramonium* is such a plant. Starve it, keep it rickety and it is not worth looking at, but feed it liberally and it grows into a bush you can sit under.

But it does not do to overfeed all plants. If you want flowers from cosmos it is best to limit its nourishment, just as an overfed hen will not lay eggs and an overstuffed woman will not bear children.

As we have unexpected geniuses in the human race so we have "sports" in plants, and as geniuses do not give rise to geniuses, so sports in plants do not yield seed that perpetuates them. Even at death the analogy does not cease for though the genius dies yet "the good men do lives after them" and the sport may be made to live on by subdivision when the original sport is dead. The Mendelian law was worked out on the common pea by an abbot in a cloister garden, and the more we learn in our garden of heredity in plants, the better will we understand heredity in man. We do not understand why one man differs from another and far be it from us to try to standardize a man. Yet such diseases as alkaptonuria and congenital cataract and probably eye color follow the Mendelian law. It may be that even our vices and virtues follow the laws of the abbot gardener. There are many analogies in human and plant diseases—scabies cured by sulphur, corresponds to mites on plants killed by sulphur. Arsenic and copper sulphate are as essential in the garden as in the pharmacopeia. The healthy robust plant needs no medicine, while its puny brother is being killed by disease—as the robust healthy man is the doctor's rarest patient.

But you can forget medicine when you are in your garden and look on your flowers as your friends. You find an artist friend in a rose. It produces nothing but beauty, and requires a place in the sun or it refuses even to produce beauty. The last thing it thinks of is seed, yet it must be richly fed. On the other hand, the drab workers with large families are represented by the rolling fields of wheat whose flowers and beauty are negligible, yet the world cannot live without them. The potato is the coal miner who works underground and yields a rich harvest. The parasite of society is interesting but deadly, like the mistletoe that saps its host. The clinging vine of the human race is seen in every forest. The thief, the cannibal, the friend, the drunkard and the glutton all have their analogies in the garden. Some plants demand a place in the sun like the stately sunflower, while others with even more brilliant color like *Lobelia cardinalis* flash a brilliant scarlet splash of color in the deepest shade of the forest. The former reminds one of the president of a learned society, while the other is like the retiring investigator who discovered insulin in a dark laboratory. Anyone who grows flowers knows that a plant which grows tall in the shade grows much less tall in the sun. Just so the human race is taller in Scandanavia where there is less sunshine, and shorter in Italy where there is so much sun.

The analogy of killing cancer by roentgen rays is seen every day in the garden. Just as it is the young growing cell that is killed by the short waves of radium so the short waves of the sun are deadly to very young plants and a gardener carefully shields his young seedlings from strong sunshine. He knows that the sunshine is stimulating in moderate doses just as roentgen rays are stimulating in small

doses. This has frequently been questioned but the growth of hair on a woman's or a child's face has been stimulated and seen to grow long when the proper dose has been given. The analogy is so exact it would be surprising to find that small doses of roentgen rays were not stimulating. The same dose of sunshine delivered to a seedling and to an adult plant of the same sort will kill the seedling and stimulate the adult plant. That is what we want to do with roentgen rays in cancer—kill the young cancer cell and stimulate the adult normal cell. Think of this when you treat cancer. You can't expect to kill the adult cancer cell. But, fortunately, it degenerates of its own accord. It is the young cancer cells we should aim to kill.

Plants breathe, feed and reproduce like human beings. They have their likes and dislikes. They have their homes and their young grow up around them. They are born, live, flourish and die as men do. They give pleasure, or profit or, like weeds, they just encumber the earth. Some are sensitive plants and droop when they are touched. Others are sturdy like the fir tree and will stand storm, starvation and freezing temperature and not only survive but thrive under the rough treatment. Young plants are raised like babies in an incubator, they graduate to the nursery and then go out into the world. There are many lessons to be learned from them. As the vine demands no thanks for its load of grapes, so a man should require no thanks for his good actions, and as the vine makes no complaint when winter stops its growth, so man should not complain when adversity overtakes him but receive it and refer it to God from whom all things come. Fame which is sought by so many is unknown in plant life for the love of fame is but the love of other men's activities.

To be a gardener does not mean to own a plot of ground with a few flowers growing in it. It means a life of study with a literature as voluminous as that of medicine. It means specializing after graduating in the general principles of horticulture and, best of all, it means a hobby of absorbing interest which can be pursued at odd moments throughout life. It keeps one in the fresh air and sunshine or at least out of doors in all weathers with moderate exercise. During active life when the day's work is done this hobby takes the place of work, so when a man's life work is done and he retires from active practice, his garden becomes the pleasure of his declining years and he can retire to it, to do a little work, to walk in it in the cool of the evening or merely to meditate.

A. H. Pirie

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-first annual meeting: West Baden Springs Hotel, West Baden, Indiana, Sept. 23–26, 1930.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting, Detroit, Mich., 1930.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. G. W. Grier Jenkins Arcade, Pittsburgh, Pa.
Annual meeting Detroit, Mich., June 23–27, 1930.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Sixteenth annual session: Los Angeles, Calif., Dec. 1-5, 1930.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. Lowell S. Goin, Wilshire Medical Building, Los Angeles.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Robert A. Arens, Michael Reese Hospital.
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Harry L. Farmer, 2930 Prospect Ave.
Meetings are held at 6 o'clock at the University Club on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. O. J. Shore, Fisher Building.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting Duluth, Minn., July 14, 1930.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Robert E. Pound, Fifth Avenue Hospital.
Meets monthly on third Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary Dr. John T. Farrell, Jr., 235 S. 15th St., Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. James M. Flynn, 282 Alexander St.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Missouri Building
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY
Secretary, Dr. D. M. Clark, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from September to July, at 7:30 o'clock in the amphitheatre of the University Hospital.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

British Empire

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christ-church.
Meets annually.

Continental Europe

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECH-O-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GE SELLSCHAFT FÜR RONTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖENTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. O. Wissing, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

DRIFT OR RIFT IN HOSPITAL ROENTGENOLOGY

To the Editor: That the conception of technicians succeeding roentgenologists in hospital work should be seriously considered and given editorial space in this Journal indicates misapprehension of the status of the roentgenologist by his confrères and hospital management.

The combined demands of both the public and physicians for institutions for adequate scientific study and care of the sick has resulted in a tremendous increase in hospital facilities. The resultant decentralization of roentgen departments only reveals the lack of trained roentgenologists capable of organizing and heading a complete department. Because it was impossible to obtain roentgenologists with executive ability, adequate training and judgment, decentralization was initiated.

The reputed advantage achieved by the close association of the clinical with the roentgenologic study in decentralization is not without evil. We have seen evidences of this in the programs of our meetings where the judgment of the head of the decentralized department has been biased by his desire to achieve therapeutic results. The head of a centralized department would be an unbiased observer.

The correlation of the clinical with the roentgenologic aspects of the cases is not insurmountable. The roentgenologist needs all the clinical data he can get; the clinician, all the assistance the roentgenologist can give. We have long since passed the stage, at least I hope we have, in which roentgen diagnoses are made from the films alone. The roentgenologist should render a continuous consultation service and be anxious at all times to have the clinician visit his laboratory and review with him the clinical aspects of the cases. Many departmental heads regularly visit the hospital roentgen laboratory seeking advice and asking assistance.

If the clinical picture does not agree

with the roentgenographic interpretation, who shall we say is wrong? A safe rule to follow is that the clinician is right (until proved wrong). On the other hand, both may be right, or there may be a technical error. Case numbers occasionally are mixed and R's and L's reversed. The production of roentgenograms is a laboratory procedure and subject to all the errors which creep into work of that nature.

The question, "What is the roentgenologist to do in a small hospital where he does most of the technical work himself"? is proposed. The answer seems to be, "Get a technician for the routine work".

The whole problem is more fundamental than Dr. Crane makes it.

First, there is the *time* factor. The busy gastroenterologist does not have time to come to the hospital, do ten gastrointestinal examinations and five barium enemas, record his findings and return to his private practice again. One or the other will suffer.

Second, the *investigative* factor. Examples are given of physicians, not roentgenologists, who have become expert in a single field of roentgen interpretation. This only occurs where one of a number of conditions prevails:

(*a*) Where the individual is a full-time staff member.

(*b*) Where the clinician collaborates with a highly trained roentgenologist.

(*c*) Where only a limited field is covered.

(*d*) Where there is an abundance of clinical material. Braasch does 3000 or more cystoscopies a year and reviews a corresponding number of films of the genitourinary tract. This is the result of efficiency in organization.

Third, the *organization* factor. This relates to the executive ability of the roentgenologist and the hospital management. Unless the hospital management realizes that the fees from the roentgen department are not to meet deficits in other departments' budgets but should be considered in the same light as the surgeon's fees for his services, hospital roentgenology will degenerate. It might be well for our societies and the American Hospital Association to have a joint session concerning this matter since it is fundamental to medical progress.

Fourth, the *teaching* factor. There is no doubt that a close association between clinician and roentgenologist serves to educate the clinician along the line of roentgen interpretation. It is doubtful if the two men could change positions successfully. The roentgenologist must never consider himself as having completed his training. No man without the studious habit should enter any branch of medical specialization.

As in every other branch of modern life we have made rapid strides in mechanical procedures but sufficient time has not elapsed for the training of men with executive ability combined with adequate roentgenologic training. Decentralization will stop when we have men qualified to direct a complete department.

Paul O. Snoke

Lancaster, Pa.

THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

The Third International Congress of Radiology will be held in Paris, July 27–31, 1931, under the patronage of the President of France and the honorary presidency of Madame Curie.

The Congress will be divided into the following sections: roentgen diagnosis; roentgen and curie therapy; radiobiology; radiophysics; natural and artificial heliotherapy, and medical electrology.

In accordance with the regulations of the international congresses, membership in this Congress will be open to: (1) regular members of national roentgen societies; (2) persons accepted by these societies.

The officers of the Third International Congress are as follows: President: Dr. Antoine Béclère; Vice-Presidents: Dr. J. Belot and Prof. C. Regaud, Paris, and Prof. Cluzet and Prof. Rechou, Province; Secretary-General: Dr. R. Ledoux-Lebard; Treasurer: Dr. Henri de Rothschild; Assistant Treasurer: Dr. Morel-Kahn; Secretaries: Dr. Claude Béclère and Dr. P. Gibert.

POSTGRADUATE COURSE

A postgraduate course given by the German Society of Radiology will be held at the Holzknecht Institute in Vienna, June 23–28, 1930. The subject of the course will be: "Progress in Radiology in Diagnosis and Therapy." There will be 20 reports on diagnosis and 5 on therapy. The fee for the complete course is 52 Austrian shillings. The number of registrations for the course is limited to sixty. Application should be made to Kursbüro der Wiener Medinischen Fakultät, Vienna VIII, Schlösselgasse 22.

AMERICAN RADIUM SOCIETY

The following is the preliminary program of the meeting of the American Radium Society to be held at the Book-Cadillac Hotel, Detroit, Mich., June 23 and 24, 1930.

1. Result of Treatment of Carcinoma of the Cervix. Dr. Simpson or Dr. Schreiner, Buffalo, N. Y.
2. Treatment of Carcinoma of the Bladder. John A. Colston, Baltimore, Md.
3. Treatment of Carcinoma of the Body of the Uterus. William Neill, Jr., Baltimore. Md.
4. Radium and Electrosurgical Methods in the Treatment of Neoplastic and Allied Diseases. Lantern Demonstration. William L. Clark, Philadelphia, Pa.
5. Calculations of Tissue Dosage in Radiation Therapy. Second Report. Edith H. Quimby and H. E. Martin, New York City.
6. Experimental Studies on Tissue Reaction to Irradiation Using a Segment of a Growing Mouse Tail as a Biological Indicator. Halsey J. Bagg and C. Robert Halter, New York City.
7. Recent Advances in Radium Therapy in Breast Cancer. William E. Costolow, Los Angeles, Calif.
8. Radium in Inoperable Cervical Nodes of Epidermoid Carcinoma. Douglas Quick, New York City.
9. The Cancer Problem—Present and Future. William H. Kraemer, Philadelphia, Penna.
10. Radium and the Roentgen Ray in the Treatment of Carcinoma of the Cervix. Henry Schmitz, Chicago, Ill.
11. A Study of Angio-endotheliomas about the Jaws. Sanford Withers, Denver, Colo.

Table Clinics

June 23, 1930—11:30 A.M. Table Clinic of Radium Technique for Head and Neck. R. E. Loucks, Detroit, Mich.

June 23, 1930—4:30 P.M. Table Clinic of Radium Technique for Thorax and Axilla. Ira I. Kaplan, New York City.

June 24, 1930—11:30 A.M. Table Clinic of Radium Technique for Pelvis, Uterus, and Rectum. William P. Healy, New York City.

COMMITTEE FOR SCIENTIFIC EXHIBITS

The President-Elect has appointed the following as members of the Committee for the Scientific Exhibit at the coming meeting of the American Roentgen Ray Society: W. M. Doughty, chairman, 628 Elm St., Cincinnati, Ohio, E. P. Pendergrass, John D. Camp, and M. C. Sosman. All those who comtemplate a scientific exhibit at this meeting should communicate with the chairman of the committee.

INDIANA ROENTGEN SOCIETY

The Indiana Roentgen Society will hold its Spring meeting in Muncie, Indiana, on Saturday, May 24, 1930. The progam will include an informal luncheon for members at noon, business meeting and exhibition of films in the afternoon, a dinner at 6:30 P. M. and an address by Dr. A. W. Erskine, of Cedar Rapids, Iowa. There will be an observance of the thirty-fifth anniversary of Professor Roentgen's discovery of the x-ray. The arrangements for the meeting are in charge of Dr. Carl S. Oakman of Muncie, who is president of the Society. It is expected that a number of wives of members will accompany their husbands, and entertainment has been provided for them.

Vol. XXIII, No. 5

DEPARTMENT OF TECHNIQUE

Department Editor: David R. Bowen, M.D., Pennsylvania Hospital, Philadelphia, Pa.

DEVELOPMENT OF ROENTGEN FILMS

A METHOD OF DETERMINING THE POTENCY OF THE DEVELOPER*

By W. EDWARD CHAMBERLAIN, M.D., *and* R. R. NEWELL, M.D.
SAN FRANCISCO, CALIFORNIA

TANK development of roentgen films is almost universal. But developer slows with use. Figure 1 illustrates a fault arising from continuing the same fixed development time throughout the life of the developer.

On measurement it proved necessary to treble the exposure if normal density was to be obtained from normal development time in the nearly spent developer. It is as if the film were three times as fast on the day when the developer was made up fresh as on the day before. Obviously the cure is to increase development time as the developer slows down. This will permit a constant exposure technique.

We have considered four methods of compensating for the deterioration of the developer.

1. The calendar. One might arbitrarily increase the time of development by one minute every five days and mix fresh developer every two weeks. We have no idea that this schedule would fit every case. It would certainly not prevent underdeveloped films some week when the work was twice as heavy as usual.

2. Running account of amount of film developed. Martin, Smith and Hodgson[1] report that after 107 films(14″×17″) have been developed in a 5 gallon tank, it requires six minutes instead of five for normal

Development 5 minutes | Development 10 minutes

Normal Exposure | Double Exposure | Normal Exposure | Double Exposure

Fig. 1. *Effect of spent developer:* The hand was taken with normal and again with twice the normal exposure. There were two films in each holder and one was given normal development time in nearly spent developer. The other was developed twice as long. Observe that the spent developer has not given sufficient density even with double exposure, while the normal exposure has turned out all right when development time was doubled.

* From the Department of Radiology, Stanford University Medical School, San Francisco, Calif. Read at the Thirtieth Annual Meeting, American Roentgen Ray Society, New York City, Sept. 17–20, 1929.

development. After 48 more are put through they recommend increasing to seven minutes, and after 36 more they suggest mixing fresh developer. The Eastman Kodak Company is at present recommending this method of control. We have found it workable and the bookkeeping not too burdensome with the printed charts provided by that company.

3. Watkins' factor applied to time of first appearance of image on a standard exposure. Wilsey[3] after reporting on the rate at which contrast is developed in a roentgen film, recommends this method. A film is exposed over part of its surface with the following factors: 15 milliampere-seconds, 60 kv., 28 inch distance, no screens. Pieces of this are developed in a tray or tumbler, counting seconds to first appearance of image. Multiplication of this appearance time by a fixed factor gives proper development time. The factor is arrived at by doing the test on fresh developer where the normal time is known (say five minutes at 65°F.). We have had good success with this. It seemed to us that the three minutes taken to do this test every morning was less of a burden than the bookkeeping for Martin's method. There are two sources of error: variations in light adaptation of the observer's eyes, and variations in exposure of the test films. Neither of these proved important.

Time to appearance of image, eyes dark-adapted	100 sec.
Time to appearance of image starting 30 seconds after looking at sky for 2 minutes	107 sec.

TABLE I

Exposure of central part of film	Time to first appearance in developer
0.25 r	110 sec.
According to Wilsey	100 sec.
1.0 r	92 sec.
4.0 r	78 sec.
16.0 r	65 sec.
64.0 r	55 sec.

From the data in Table 1 we conclude that an error of 20 per cent in exposing a Wilsey test film would lead to a mistake of only about 1 per cent in development.

4. Method based on time to develop to standard density a test film exposed to 0.33 r. We made this exposure on our deep therapy machine which is kept calibrated in international r-units. We arrived at a standard density by developing test films to various degrees and choosing the one of maximum contrast. (Loss of contrast from moderate degrees of overdevelopment is very slight, and we believe it might be well in the interest of shortening roentgen exposures, to set the standard at very full development.)

Wilsey has used a sensitometer and measured the films with a photometer. Lacking these instruments, we were able to measure contrast by matching equal densities. A contrast scale was made of a staircase of 0.23 mm. copper sheets, running from one to seven thicknesses, each step 1 inch wide. This was laid over an exposure holder containing six 8″×10″ films and exposed under the deep therapy

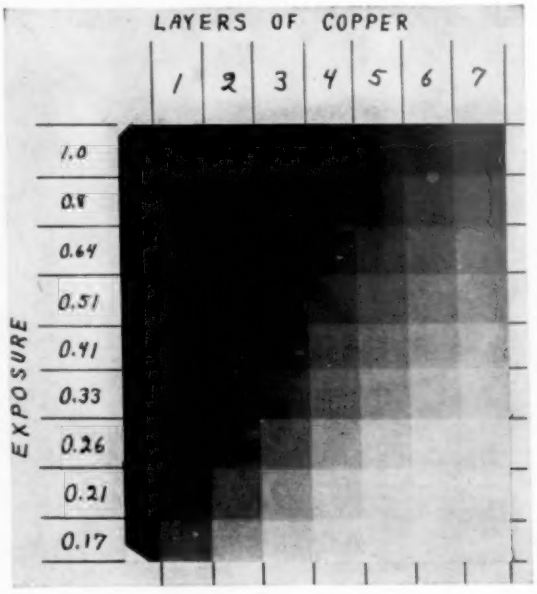

FIG. 2. Test film for seeking optimum development. Six of these were made and developed for various times, then compared with each other for contrast.

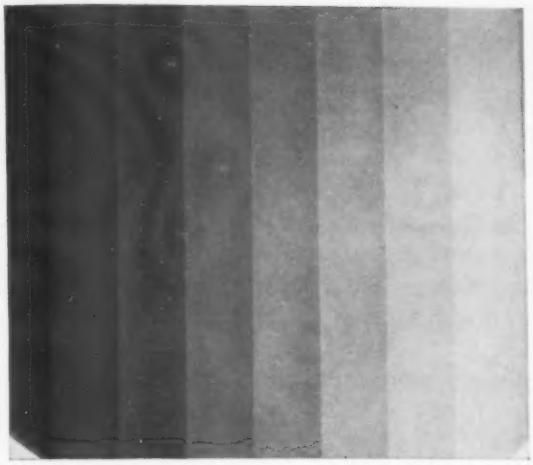

Fig. 3. Standard film for daily developer control. A fresh film exposed the same as this is developed each day and development time increased or decreased according as it is lighter or darker than the standard.

machine to filtered roentgen rays (lambda effective 0.17Å) varying in 20 per cent steps from 1 r down to 0.17 r. The resultant films were then developed for times varying in 25 per cent steps from 215 seconds up to 657 seconds. By comparing the exposure strips which had developed to about the same density it was possible to make a rather precise comparison of the contrast steps and to see which development had given the steepest contrast. Then another pack of 8″×10″ films was exposed under the copper staircase to 0.33 r over the whole surface. One of these, developed for the just determined optimum time served as a standard. Each day another was developed for the time indicated by the last previous test. If it was one step lighter than the standard, development time was increased 15 per cent; if one step too dark, it was decreased 15 per cent. (With these hard rays, the top and bottom films in a pack of eight show no difference in exposure.)

Having tried methods 2, 3 and 4, we observe that they all work.

We wish to point out that Martin's and Wilsey's methods take account of the developer only. Our method (No. 4) adjusts for changes in speed of film as well as for weakening of developer. Our method also shows up variations in contrast, whether due to changes in the film or in the chemical make-up of the developer. We have also found it very useful for comparing

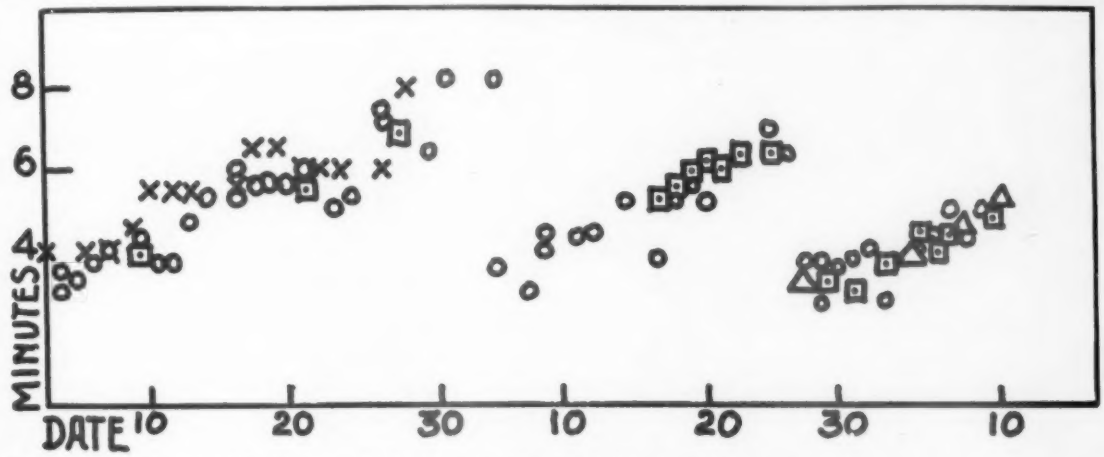

Fig. 4. Experience with three methods of control of fixed time development.

Circles show time to develop 0.33 r exposure to standard density. Twenty gallon tank of Bucks developer, at 65°F. Eastman contrast films.

Crosses show same test for 13 gallon tank, with time scale stretched to 20/13 to make up for the difference in volume.

Squares show seconds for first appearance of image on development of Wilsey's test films, multiplied bya constant factor (0.05) to bring to comparable scale.

Triangles show minutes' development, indicated by accounting of number of films already developed.

the films furnished by different manufacturers.

We are struck by the very flat top of the contrast curve in development. Remarkably little change of contrast is observable between 215 seconds', and 657 seconds' development (in ten day old developer). This extraordinary latitude, and the fact of satisfactory contrast at widely different degrees of development suggest the feasibility of a return to the method of individual development of each film to what is judged to be the best density. In the present study we have considered only the problem of so-called "fixed time" or "time and temperature" development.

In comparing our statement regarding the effect of development on contrast with Wilsey's curves, note that we are speaking of contrast in a moderate range of middle densities, whereas he has taken contrast averaged over the whole range of roentgenographically useful densities.

It would seem possible for film manufacturers to provide, for each batch of films (emulsion number): (1) finished test films, showing best obtainable contrast and *standard density*, and (2) strips of exposed but undeveloped film to be developed in the user's tank, so that he could adjust his development time to make a test strip match the standard.

Unless or until the film manufacturers give such a service, we would recommend:

Take five minutes in fresh developer at 65°F. as correct (or whatever the manufacturer recommends for the developer and films used). Control by daily test according to Wilsey (Watkins' factor). Keep developer at 65°F. or at least correct the development time for temperature variations according to manufacturer's published charts (about 5 per cent per degree F.).

SUMMARY

Several methods are reviewed for adjusting the time of tank development to the state of exhaustion of the developer. A method is described that assures development of proper exposures to proper density, accounting not only for the activity of the developer but also for speed of the film. Experience with these methods is summarized and tentative recommendations are made.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

Head

Rosenheck, Charles. Encephalography: The development of hemiplegia following its use; with report of a case. *Arch. Neurol. & Psychiat.*, 1929, *22*, 575–582.

The author reports a case in which the procedure of encephalography was attributed as a cause of hemiplegia which followed. He describes the method which was employed and in conclusion states that the withdrawal of the fluid should be done gradually and the air introduced slowly. In discussion of this paper Friedman reports 5 deaths in 200 encephalographies and Stephenson states that he thinks the procedure is dangerous.—*E. P. Pendergrass.*

Haguenau, and Gally. Exploration lipiodolée rachi-médullaire and cranio-cérébrale. (Rachiomedullary and craniocerebral exploration by means of lipiodol.) *J. de radiol. et d'électrol.*, July, 1929, *13*, 369–382.

This paper constitutes a report of the present status of the exploration of the cranial and spinal cavities by means of lipiodol.

A. The exploration of the cranial cavities includes: (1) the ventricles; (2) the subarachnoid spaces; (3) the cerebral arteries; (4) the venous sinuses; (5) cystic cavities; (6) osseous canals and foramina of the base of the skull; (7) osseous sinuses, and (8) convolutions and fissures of the brain.

1. Ventriculography. (*a*) Injection of lipiodol directly into the lateral ventricles. After a trephine puncture, according to the routine technique, either in the frontoparietal or in the occipital region, 3 to 4 c.c. cerebrospinal fluid is extracted and through the same needle 2 to 3 c.c. of lipiodol is injected. The lipiodol is very well tolerated but its distribution within the ventricles, on account of the high viscosity, is so manifold that a diagnostic interpretation is very difficult. (*b*) Injection of the "ascending" lipiodol. The injection of the "ascending" lipiodol by the lumbar route was attempted in several instances and though the lipiodol often ascended through the foramina of Magendie, Luschka and Munro into the ventricles the pictures obtained proved of little diagnostic value. (*c*) Injection of the ascending lipiodol "emulsion." More recently the ascending lipiodol was injected by the lumbar route in the form of an "emulsion." The technique is as follows: The patient is placed in a sitting position as for lumbar puncture; 5 c.c. of cerebrospinal fluid is extracted and this is mixed in an asceptic tube with 5 c.c. lipiodol and reinjected. The disadvantages of the method are that there is always a certain danger in performing a lumbar puncture in patients with cerebral tumors, that the distribution of the lipiodol within the ventricles, especially in the cases with increased intracranial pressure, is very inconstant and that it often leads to rather severe reactions such as headaches, vomiting, increase in temperature, etc.

The conclusion is reached that lipiodol is of little value in ventriculography.

2. The subarachnoid cavity and subarachnoid cisternae. The injection of lipiodol into the cerebral subarachnoid cavities and certain cisternae is well tolerated. The authors injected in several instances the cisterna magna as well as the basal cisternae and obtained satisfactory roentgenograms. The lack of symmetry on the two sides as well as the displacement towards the right or left from the midline is of diagnostic value.

(3) Cerebral arteries. Following Moniz' work on arteriocerebral encephalography (with sodium iodide) the authors injected lipiodol into the cerebral arteries. Since lipiodol is not injurious to the neighboring tissues it is not necessary to expose the common carotid, as in Moniz' procedure, but the injection can be done through the skin. No ill effects were observed from the injection of one c.c. of lipiodol in several patients suffering from general paralysis. However, in 2 cases of brain tumors with increased intracranial pressure such severe reactions occurred that the method had to be discarded.

(4) Venous sinus encephalography. Venous encephalography by means of the injection of the sinuses is of considerably greater advantage than the arterial encephalography as advocated

by Moniz. It is a method which is entirely harmless and easy to perform. The procedure consists in a preliminary trephination (under local anesthesia) just above the superior longitudinal sinus on the vertex, or opposite the torcular Herophili on the external occipital protuberance. After the wound has healed, the needle is inserted directly through the scar into the sinus and 5 c.c. of lipiodol (warmed to 37° C.) is injected as rapidly as possible, while an assistant compresses the jugular veins so as to retard the venous circulation and thus the distribution of the lipiodol. The roentgenogram is taken during the injection or immediately following the iniection, the patient being placed in a recumbent position. As soon as the injection is completed and the needle is extracted, a finger is pressed against the place of injection and the patient is brought into a sitting position. In this way the negative venous pressure (which is produced by the sitting up of the patient) immediately stops the bleeding. Occasionally a mild coughing spell develops, due to the absorption of the lipiodol in the lungs. The method is so innocous that most patients are able to return to work within ten minutes after the injection. The roentgenograms, as a rule, show a good visualization of the superior longitudinal, of the lateral, of the inferior petrosal and of the cavernous sinuses as well as of the upper part of the jugular vein. The procedure is of a certain diagnostic value in sinus thrombosis and cerebral tumors.

More recently the authors injected the superior longitudinal sinus after ligating the sinus just above the torcular Herophili so as to produce an inverse circulation of the blood during the injection.

(5) Intracystic or intraventicular lipiodol injection. If during the course of an operation a cyst is encountered the nature and topography of which is not sufficiently known, lipiodol may be injected into the cyst. Roentgenograms taken three to four days later may be used for the purpose of differential diagnosis from ventricular cavities.

(6) Osseous canals and foramina of the base of the skull. The injection of several osseous canals and foramina was attempted in connection with local therapy for neuralgias. The supraorbital, infraorbital foramina, as well as the foramen rotundum and ovale were iniected with success. In one case a diffusion of the lipiodol along the inferior maxillary nerve was observed.

(7) Osseous sinuses. In one instance the sinuses of the base of the skull were injected by means of a catheter through the sphenoidal ostium.

(8) Cerebral convolutions. In one case 5 c.c. of lipiodol was injected into the cisterna basalis (with patient lying on the side) and a good outline of the fissures and convolutions of the brain was obtained.

B. The exploration of the spinal cavities includes: (1) the epidural space; (2) the subarachnoid space, and (3) the ependymal cavity.

The lipiodol for the exploration of the spinal cavities may be injected by the high route, through the cisterna magna, and by the low route through lumbar puncture. It is essential that in both instances the descent or the ascent of the lipiodol be controlled under roentgenoscopy.

(1) Exploration of the epidural space. In case of exploration by the low route, the lipiodol is injected through the sacrococcygeal hiatus, while in the exploration by the high route the injection is done through the cervical or dorsal regions.

The exploration of the epidural space is, because of its limited application, of little practical value.

(2) Subarachnoid exploration. The injection of lipiodol into the subarachnoid space is made between the axis and atlas, when using the high route, and in the lumbar region, when using the low route. The site of the occlusion as well as the appearance of the oil at the site of the occlusion are important from a diagnostic standpoint. Three types of drop formations are distinguished: (*a*) the massive drop, (*b*) the bead or droplet formation, and (*c*) the double festoon lines. The method is indicated in spinal cord tumors, persistent neuralgias and certain types of paraplegias.

(3) Ependymal cavity. In one case with rather advanced syringomyelia, the syringomyelic cavity which was at the level of the eleventh dorsal was made visible by means of the lipiodol.

The general conclusion is reached that while the craniocerebral roentgen diagnosis does not allow precise indications as yet, the medullary compressions of the spinal cord can be well demonstrated with the aid of lipiodol. They can be diagnosed earlier and more accurately than

with the clinical methods hitherto used.—*T. Leucutia.*

Dariaux, and Hartmann, Edward. Radiographies de canaux optiques élargis dans deux cas de maladie de Recklinghausen (avec projections.) (Roentgenograms of enlarged optic canals in two cases of Recklinghausen's disease.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 227–229.

A marked enlargement of the optic canals was found in two cases of Recklinghausen's dis ease.

In connection with this the different techniques for the roentgenography of the optic canal are discussed. At the instigation of Morax one of the authors has evolved the following procecedure: The patient is placed face downward with the forehead and nose on the film. The tube is centered over a point which lies 7 cm. cranially to the external occipital protuberance and 6.5 cm. laterally to the sagittal plane. The angulation of the tube is 31° cranially and 35° laterally.—*T. Leucutia.*

Neck and Chest

McPhedran, F. Maurice. The diagnosis and classification of pulmonary tuberculosis in childhood and adolescence. *Am. Rev. Tuberc.* Oct., 1929, *20*, 532–636.

The author concludes that the most important single diagnostic procedure in the recognition of the early manifest and of the latent tuberculous lesion is the roentgen examination. Several years' observation of children living in household contact with patients who have positive sputum has shown conclusively that pulmonary infiltrations may be discovered months or often years before pulmonary tuberculosis becomes manifest either by symptoms or by physical signs.

Secondly, lesions of most types, if discovered during the latent stage, may be so treated that the child in whom they occur is never made ill by their presence.

The representation of lesions in the hilus was selected in order to demonstrate the size that such a lesion must obtain before it can be perceived. They illustrate the difficulties in the way of recognizing the smaller lesions that make it impossible to diagnose uncalcified nodes in the vast majority of instances. There is, perhaps, no pulmonary lesion concerning the diagnosis of which so much confusion exists.

The various lesions are discussed and are grouped vertically into parenchymal infiltrations characteristic of childhood, lesions of the tracheobronchial lymph nodes which are almost invariably the result of initial infections, apical infiltrations which typically begin to appear in adolescence and at this period constitute the majority of the recognizable and significant pulmonary invasion, and chronic nontuberculous infections that seriously affect the health, are commonly mistaken for tuberculosis of childhood type and are often forerunners of far advanced bronchiectasis of adult life.

Anyone interested in this subject should not miss the opportunity of studying this paper as the author describes at length the roentgen appearances and the commonly associated lesions. A summary of these is as follows:

	The Lesion	Roentgen Appearances	Commonly Associated Lesions
A	Focal tuberculosis, caseous or calcified nodule.	Isolated, sharply defined subpleural density; often obscured by dense structures.	Associated lymph nodes recordable if calcified. If caseous, recordable only if much enlarged.
B	Tuberculous consolidation of a lobe or wedge, progressive or unstable. Calcified spots remain if it clears.	Lobar or roughly wedge-shaped mass that increases or fluctuates in extent, or excavates.	In infancy caseous nodes almost always; in older children nodes calcified or uncalcified. B may be preceded or accompanied by soft or active D.

	The Lesion	Roentgen Appearances	Commonly Associated Lesions
C	Tuberculous consolidation of a lobe or wedge, retrogressive and benign. Few strands remain when it clears.	Homogeneous irregular wedge, commonly most dense anteriorly (oblique view); maximum density and extent at onset; clears slowly, starting in axilla.	Sometimes calcified nodes. Characteristically no associated infiltration.
D	Diffuse, childhood type tuberculous infiltration. Confluent bronchopneumonia is the serious lesion of this type and often precedes E.	Spots, strands, or both, denser towards pleura in tangential views. Indolent lesions strand-like and unilateral. Progressive lesions show confluent spots, which may develop into B.	Tuberculous tracheobronchial nodes, usually calcified in older children; demonstrable uncalcified nodes rare, occur chiefly in infants and colored children, and cause bad prognosis when more than two.
E	Miliary tuberculosis.	Universal soft mottling.	Caseous tracheobronchial nodes usually; almost always in infants. B or D often precedes E.
F	Tuberculosis of tracheobronchial lymph nodes, uncalcified. Demonstrable only when massive.	Large convex masses project from hilum (and) (or) from mediastinum into the parenchyma. Small lesions are not demonstrable.	In infants usually a wedge-shaped consolidation, B; less often D, diffuse. In older children, D, B, or A, the last chiefly in colored.
G	Tuberculosis of tracheobronchial lymph nodes, calcified.	Granular, stippled, or irregular dense shadows on hilum shadow (and) (or) shown by oblique exposure in mediastinum; often enormous without history of illness.	The parenchymal primary focus, usually calcified may be obscured by opaque organs. Diffuse childhood type infiltration before 12th year; apical adult type lesion relatively frequent after 12th year.
H	Apical, adult type infiltration of children and adolescents.	Spots, or spots and strands, or wedges, or irregular masses, based on apical pleura, often most easily demonstrable below the 3rd or 4th rib posterolaterally.	Many apical infiltrations are preceded by calcified tracheobronchial nodes, which occur as often in the opposite as in the same lung. They are the cause of apical lesions.
X	Chronic infectious non-tuberculous pulmonary lesions.	Irregular densities may coalesce into cloud on heart or diaphragm; or, if discrete, simulate beading on vessels, which are prominent or distorted. Chiefly on left. Often bilateral. Mostly in girls.	Lesions of accessory nasal sinus should always be sought. It may be primary or secondary.

The author's summary is as follows: 1. The apparent sudden onset of acute tuberculosis of children is usually preceded by a period of development of a latent lesion occupying months or even years. Lesions discovered while latent may be treated so that clinical disease is prevented.

2. Histories and illustrations are submitted to show that the diagnosis and supervision of the course of tuberculosis in children depend largely on the roentgenogram.

3. Illustrations have been selected to show typical examples of each form of lesion in such a way that the site of its physical characteristics particularly the variations in density of different parts of the lesion in relation to each other and to the site, may be clearly represented.

4. The representations of lesions of the hilus demonstrate the size that such a lesion must attain before it can be perceived. They illustrate those difficulties in the way of recognition of smaller lesions that make it impossible to diagnose uncalcified lymph nodes in the vast majority of instances.

5. Tuberculous infiltrations of the childhood type are divided into three somewhat arbitrary groups. Going along with the roentgenographically determined anatomical structure of each group there are certain clinical and prognostic characteristics.

6. Differentation of tuberculous from nontuberculous infiltrations is discussed and methods of roentgen diagnosis described.

7. Apical lesions in children should not be dismissed as scars, unless composed wholly of calcium and dense strands. Serial observations should be made to be certain that spread does not occur. Children showing progressive infiltration starting from a sharply defined apical density are not uncommon. Accuracy and comparability of roentgenograms are essential to estimate the course of latent lesions, to aid decision on methods of treatment of clinical disease, and to determine when a child particularly an adolescent, may be safely returned to work. The rapid subsidence of symptoms does not represent the end of danger. Because of the suddenness of severe relapse common in adolescence, treatment should be prolonged till lesions are demonstrably stable.—*E. P. Pendergrass.*

Kohn, J. L., and Koiransky, H. Successive roentgenograms of the chest of children during measles. *Am. J. Dis. Child.*, Aug., 1929 *38*, 258–270.

Serial roentgen examinations were made of 130 children between the ages of seven months and twelve years in the various stages of measles. Pneumonic infiltration and consolidation was noted in all stages of the disease even in the preëruptive stage of mild cases who had no demonstrable clinical symptoms indicating a complication of the disease.

There was evidence of pneumonic involvement in 62.4 per cent of all patients less than four years of age and in 42.2. per cent of patients four years old and over.

Roentgen examination showed the involvement to be of three types: (*a*) Large homogeneous triangular consolidation; (*b*) large homogeneous opacities obscuring the hilus and paravertebral regions, and (*c*) disseminated confluent fine and coarse mottling in various areas of the lung field.

The pneumonic consolidation was not necessarily confined to the lower lobes and seemed to occur with equal frequency in the upper portion of the lungs. Microscopic examination of the excised lung revealed bronchopneumonic areas about the bronchi which in pronounced cases become confluent.

These pneumonic shadows persisted for from two to four weeks after their appearance in 5 cases.—*L. R. Sante.*

Lestocquoy, Ch., and Lehmann, Robert. Étude radiographique et anatomique du médiastin; contribution a l'étude de l'adénopathie trachéo-bronchique. (Roentgenographic and anatomic study of the mediastinum; contribution to the study of tracheobronchial adenopathy.) *J. de radiol. et d'électrol.*, June, 1929, *13*, 337–343.

On the basis of numerous experiments on cadavers, the roentgenographic appearance of the mediastinal structures was studied in the oblique and straight lateral positions. It was found that roentgenograms taken in the oblique position do not give a clear picture of the mediastinal contents due to the fact that the large pulmonary vessels and the left auricle of the heart are superimposed on that region of the mediastinum where tracheobronchial adenopathies are most commonly found. The roent-

genograms taken in straight lateral position, however, give a satisfactory view of the mediastinal space permitting an easy recognition of tracheobronchial adenopathy or other tumors of the mediastinum.

It is concluded that the roentgenographic examination in straight lateral position is of greater diagnostic aid than that in the oblique position.—*T. Leucutia.*

PIFFAULT, and BARREAU. Gros anévrysme de la crosse de l'aorte. (Large aneurysm of the aortic arch.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 240–241.

A case of a rather huge aneurysm of the aortic arch is presented and in connection with this the differential diagnosis from hydatid cyst and mediastinal tumor is briefly discussed.

It is recommended that in doubtful cases a therapeutic dose of roentgen rays be given so as to test the radiosensitivity of the tumor. In the case mentioned there was no response to the irradiation and this strengthened the diagnosis of aneurysm. The patient died later and the post-mortem examination confirmed the clinical diagnosis.—*T. Leucutia.*

MAINO, MARIO. Pneumotorace artificiale e circolazione polmonare (Artificial pneumothorax and pulmonary circulation.) *Radiol. med.*, Nov., 1929, *16*, 1115–1126.

In studying the relation of artificial pneumothorax to the circulation in the lungs the author made experiments on animals which confirmed the opinion he had previously held in regard to it. He found that the circulation became less active in the lung contracted by artificial pneumothorax, while it became more active in the opposite lung. This does not injure the normal lung but on the contrary is a help to it. The increase in the amount of circulating blood counterbalances the decrease in the total amount of air inspired so that the lung is not obliged to do excessive mechanical work. This in turn prevents the anoxemia that would result from such an excess of work.—*A. G. Morgan.*

PODKAMINSKY. Sur l'aspect radiologique des divers stades de l'emphysème pulmonaire et de l'état préemphysémateux. (The roentgenologic aspect of different stages of pulmonary emphysema and the pre-emphysematous state.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 230–232.

Three stages of pulmonary emphysema are differentiated, the roentgen appearance being as follows: Stage 1. The diaphragmatic dome is slightly flattened and lowered, while its respiratory excursion remains practically normal. There is a slightly increased transparency of the lungs at the base and the heart shows a normal appearance. There is a very slight straightening of the fifth, sixth and seventh ribs. Stage 2. The diaphragmatic dome is nearly horizontal and lowered to the level of the eleventh rib and its excursion is definitely diminished. There is straightening of the fifth, sixth and seventh ribs with augmentation of the costodiaphragmatic sinus. There is an increased transparency of the entire lung fields and there is a lowering and deviation (simple rotation or combination in the three axes) of the liver. The intercostal spaces are enlarged. The heart shadow is smaller than normal and the Holzknecht, Sinnhuber and Yagič signs are positive. Stage 3. The same signs are present as in the second stage with the exception that they are considerably accentuated and that the right heart shows a marked dilatation.

In addition to the above stages the author describes a pre-emphysematous stage observed in men or workers performing heavy labor, which is characterized by the so-called "pre-emphysematous trigone" first described by the author. The catheti of the triangle are formed by the right border of the vertebral column and by the diaphragmatic dome, while the hypotenuse is constituted by the upper border of the liver. The image which is visible in deep inspiration only is the result of a dilatation of the posterior part of the base of the right lung projecting between the diaphragm and the right lobe of the liver. In case of pleuro-phrenopericardiac adhesions this image is obscured.—*T. Leucutia.*

DYKE, CORNELIUS G., and SOSMAN, M. C. The postural treatment of postoperative massive atelectatic collapse. *Surg., Gynec. & Obst.*, Dec., 1929, *49*, 752–763.

The author's work is based on 14 cases occurring at the Peter Bent Brigham Hospital during the years 1925–1928 inclusive. Postoperative massive collapse is now recognized as a separate disease entity. The etiology and

the mode of production are discussed in detail. Of the clinical varieties two types are recognized, the fulminating and the insidious. In the former the onset is sudden; in the latter it is much slower and is the more usual form. It is rarely fatal and deaths should occur only in the simulataneous bilateral cases.

Dyke and Sosman wish especially to call attention to the frequency of the disease, the methods of prevention, the postural method of treatment, the infrequency of clinical diagnosis (2 out of 14), and the ease of recognition if roentgen examination is made routinely in all cases with postoperative pulmonary complications. Their conclusions follow:

1. Obstruction to the air passages is absolutely essential for the production of the disease. Thick tenacious mucus is the obstruction material.

2. Usually many secondary factors are involved in the production of the disease, i.e., lowered vital capacity, raised cough reflex, lack of frequent postural change after and during operation, and the limitation of thoracic and abdominal mobility due to operation.

3. The disease is not a reflex nervous phenomenon.

4. The condition does not occur contralateral to the side operated upon unless the patient lies on his side during the operation, as in renal operations.

5. The maneuver advocated by Sante is very efficacious in treating the disease.

6. Hyperventilation of the lungs with carbon dioxide and oxygen should be employed at the end of operation and during the first forty-eight hours postoperative.

7. Frequent changes of posture should be made during the first few days after operation, and sedatives should be curtailed.

8. The mortality from the disease is very low.—*R. S. Bromer.*

Gally, and Bernard. Diverticule congénital du tiers inférieur de l'oesophage. (Congenital diverticulum of the lower third of the esophagus.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 226–227.

A congenital diverticulum of the esophagus occurring in a woman fifty years of age is briefly described. The diverticulum was situated on the right posterolateral wall of the lower third of the esophagus forming a rather large pedunculated sac. It caused no clinical symptoms whatever.—*T. Leucutia.*

Abdomen

Jaubert de Beaujeu, A. Éventration diaphragmatique—estomac en bissac déplacement a gauche de l'antre pylorique et du pylore. (Diaphragmatic eventration—two sac shaped stomach, displacement of the pyloric antrum and pylorus to the left.) *J. de radiol. et d'électrol.*, Sept., 1929, *13*, 508–510.

An eventration of the stomach leading to a posterior biloculation and displacement of the pylorus to the left is described in a woman sixty-six years of age and the roentgenograms are presented.

The condition is interesting since it had no influence whatever on the normal function of the gastrointestinal tract. The only symptom observed was a sensation of heaviness in the left upper quadrant (lasting for a period of over ten years).—*T. Leucutia.*

Piffault, and Barreau. Inversion et biloculation de l'estomac. (Inversion and biloculation of the stomach.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 239–240.

The case is briefly described on account of the unusual circumstances under which it came to examination. The patient's sister was supposed to have a gastrointestinal analysis by means of barium meal and since she was reluctant to undergo the examination patient had one done on himself to convince her of the harmlessness of the method. To the great surprise of the roentgenologist an inversion and biloculation of the stomach was found. It is interesting that the patient, who is twenty years of age, has never presented any gastric symptoms and feels entirely well.—*T. Leucutia.*

Caillods, G., and Cottet, P. Volvulus subtotal et volvulus total de l'estomac. (Subtotal and total volvulus of the stomach.) *J. de radiol. et d'électrol.*, Sept., 1929, *13*, 497–502.

On account of the rarity of this condition the authors describe a subtotal volvulus of the stomach which occurred in a patient twenty-nine years of age two years following a war injury to the left upper quadrant, and a total volvulus of the stomach which occurred in a

woman thirty years of age, apparently without previous injury.

A detailed account of both cases is given and roentgenograms are reproduced and explained by schematic drawings.—*T. Leucutia.*

Didiée, J. Un cas de diverticule vrai du duodénum. (A case of true diverticulum of the duodenum.) *J. de radiol. et d'électrol.*, June, 1929, *13*, 346–347.

A case of a true diverticulum of the duodenum is described and the roentgenogram presented. At the five hour examination there was a complete emptying of the diverticulum.

The opinion is expressed that diverticula of the duodenum occur more frequently than assumed. As a rule, they remain symptomless and thus undetected until some inflammatory, mechanical or neoplastic complication leads to a roentgen examination bringing about their discovery.—*T. Leucutia.*

Breton, Marc, Barret, G., and Blondeau, Andrè. L'image radiographique d'infraversion des deux premières portions du duodénum. (The roentgenographic image of the infraversion of the first two portions of the duodenum.) *J. de radiol. et d'électrol.*, Sept., 1929, *13*, 465–480.

In 1927, Breton described the infraversion of the first and second portions of the duodenum as follows: The pylorus is low, the duodenum ascends first obliquely (describing a curvature with the concavity downward), then vertically to the right of the spine, and then again somewhat obliquely upward and towards the left of the spine. Finally, it descends vertically along the left border of the spine, thus completely reversing the usual picture.

Since 1927 the authors observed infraversion of the duodenum in 7 additional cases, all of which are described more or less in detail and illustrated with numerous reoentgenograms.

The opinion is expressed that the infraversion of the duodenum is more frequent than hitherto supposed and that it leads to a rather important clinical symptomatology which cannot be explained on any other basis.—*T. Leucutia.*

Breton, Marc. L'image radiographique d'infra-version des deux premières portions du duodénum. (The roentgenographic image of the infraversion of the first two portions of the duodenum.) *J. de radiol. et d'électrol.*, Dec., 1929, *13*, 655–659.

Infraversion of the duodenum is not the result of a mobile duodenum, that is, of a congenital anomalous fixation of the duodenum but is the result of ptosis. The traction on the first two portions of the duodenum by the ptotic stomach and colon are here of great importance. Sooner or later this traction results in an elongation of the pancreatic appendages leading to ptosis of the duodenum.

The author is of the opinion that the rôle of ptosis in abdominal pathology is greatly exaggerated. Yet in this particular instance the part of ptosis in bringing about the mobility and thus infraversion of the duodenum is more plausible than the assumption of the so often stressed congenital malformation.—*T. Leucutia.*

Balli, R. Sfinteri o anelli di contrazione del colon. (Sphincters or contraction rings of the colon?) *Radiol. med.*, Nov., 1929, *16*, 1114.

The author described under the name of sphincters of the colon those special contraction zones that are known to all roentgenologists. It has been suggested that this name be changed to contraction rings. The name sphincter means a bundle of muscles that has a special and well-individualized function. A ring means a rigid structure without special function, such as the inguinal ring, the crural ring and the umbilical ring. If the idea of function is to be shown they must be called contraction rings; but the author says that the words ring and contraction express contradictory ideas. In addition to that there are clinical reasons for not calling these structures contraction rings. Examination of children with habitual constipation has shown that this condition may be due not only to a congenital anomaly of the colon (dolichocolon) but also to greater prominence of the sphincters which extend from the improperly named ileocecal sphincter to the ampulla of the rectum and regulate intestinal peristalsis and antiperistalsis. This shows that they really are true sphincters and as they are found in young infants they cannot have been caused by altered function for a long time. And it has also been found that constipated infants

may have supernumerary sphincters in segments of the colon that are congenitally longer than normal. Therefore the author thinks his name of sphincters of the colon should be kept. —*A. G. Morgan.*

Genitourinary System

Kretschmer, Herman L. Supernumerary kidney. *Surg., Gynec. & Obst.*, Dec., 1929, *49*, 818–831.

That true supernumerary kidney is probably the rarest of congenital renal anomalies seems to be the uniform opinion of clinicians as well as of various authors of textbooks. Kretschmer in a review of the literature was able to collect 29 cases and the case presented in his paper brings the number available for study up to 30. Many reports of so-called supernumerary kidney are really those of double kidney; in a few instances, a horse-shoe kidney has been reported as a supernumerary kidney. Of the 30 cases, 8 were discovered at autopsy and in 21 the diagnosis was made clinically.

The paper contains a table showing in detail the author reporting each case, the type of case, the age, sex, side involved, location, course of the ureter, report of cystoscopic examination, pathology of the accessory and the other kidney, duration of symptoms, an account of the symptoms, the presence of a palpable tumor, the preoperative diagnosis, the operation performed and the result. Of special interest to the roentgenologist are the illustrations of the pyelograms made on the case reported by Kretschmer himself. At operation a mass lying behind the peritoneum and behind and below the right kidney, was aspirated and about 3 pints of purulent fluid was obtained which had the odor of urine. The right kidney was distinctly separate from this tumor mass. After operation a pyelogram was obtained by injecting the right ureter and also by injecting the sinus tract which was left after operation. Two pelves were seen, the normal being obtained by the ureteral injection, the other by the injection of the sinus.

In the group of reported cases in which the supernumerary kidney and its ureter are rudimentary the preoperative diagnosis is almost never, if ever, made. In the group in which two ureters on one side fuse outside the bladder to terminate as one ureter in a normally placed ureteral hillock, difficulties are presented in diagnosis, in that the cystoscopic picture is that of a normal bladder with two ureteral orifices. If a pyelogram is made with the catheter low down, a picture of both kidneys may be obtained and a positive diagnosis made.

In Kretschmer's case the preoperative diagnosis rested between perinephritic abscess and carbuncle of the kidney. The diagnosis of three kidneys was made at the time of the first operation and was verified by an injection into the drainage tube in the loin with a simultaneous pyelogram, which showed the pelvis of the normal kidney as well as the large hydronephrotic sac of the supernumerary kidney.

In the group in which the ureters do not fuse and three ureters are seen in the bladder on cystoscopic examination, or the group is which the ureters terminate extravesically, a clue to the diagnosis is obtained and the diagnosis may be verified by a pyelogram. In this group it is of course necessary to differentiate between a supernumerary kidney and double kidney with an accessory ureter.

In the case reported the two kidneys on the right side were removed. The hydronephrotic sac of the supernumerary kidney was infected. —*R. S. Bromer.*

Raffo, Vittorio, and Vallebona, Alessandro. Quelques remarques à propos de la cystoradiographie. (Some remarks with regard to cystoroentgenography.) *J. de radiol. et d'électrol.*, Sept., 1929, *13*, 481–496.

Recently Gottlieb and Strokoff in their work on prostatography (*J. Urol., 1928, 25*, No. 5) referred to the so-called combined method of cystoroentgenography which they called the method of Reiser. The authors wish to draw attention to the fact that the combined method of cystoroentgenography was described by one of them (Vallebona) for the first time in 1925, that is, one year previous to the publication of Reiser.

The technique of Vallebona is as follows: Introduction of a catheter (with large diameter) into the bladder; complete emptying of the bladder and introduction of 30 c.c. of barium sulphate in thick aqueous suspension, then injection of air or oxygen (100, 150, 200 c.c.) until the patient complains of slight pain. Before taking the roentgenograms the patient is asked to turn around once or twice so as to obtain a uniform coating of the vesical mucosa

by the opaque medium. The roentgenograms are taken in the usual way. The bladder lesions appear either in the form of filling defects or in the form of dense shadows.

The method of Reiser (using iodized oil) does not always demonstrate the irregularities plainly since the iodized oil, because of the higher viscosity, fails to spread evenly on the surface of the mucous membrane. Moreover, not infrequently roentgenograms are obtained which do not correspond to actual conditions.

The authors have used the combined cystoroentgenography now for a period of three years with very satisfactory results. Of course the filling defects and increased opacities indicate only the site and extent of the lesion, they do not indicate the true nature of the lesion. Therefore the method can be used only in conjunction with other clinical methods.

Twenty-six beautiful roentgenograms are included to demonstrate the value of combined cystoroentgenography in different pathological conditions.—*T. Leucutia.*

LOTSY, G. O. Sur les difficultés causées par la bilharziose dans l'examen radiographique des voies urinaires. (The difficulties caused by bilharziasis in the roentgen examination of the urinary tract.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 232–239.

As is known, the Bilharzia worms lay their eggs in the submucosa of the bladder, ureters, kidney, rectum, colon, etc. The irritation caused by the continuous piling up of the eggs (as foreign bodies) leads to a large round cell infiltration of the neighboring tissues, resulting later in mucous papillomas of various forms. After the lapse of one year the eggs become calcified.

The author presents numerous cases illustrating the different roentgenological aspects of papillomas and calcifications in bilharziasis of the urinary tract.

The following three difficulties are especially emphasized from the point of view of differential diagnosis: (1) possible confusion with calculi of the bladder, ureter and kidney; (2) possible confusion with papillomas or infiltrations of the intestinal tract which project in the region of the bladder, ureter or kidney, and (3) misjudgment of the papillomas and calcifications of the urinary tract in case there is elongation and tortuosity of the ureters.

By the simple use of compression, evacuation of the bladder and projection in different views the author was able to arrive at a definite diagnosis in nearly all the above instances. Therefore he is convinced that the injection of opaque solutions for the purpose of differential diagnosis, as advocated by others, is not necessary.—*T. Leucutia.*

HARET, and FRAIN. Radiographie de la vessie; une image rare. (Roentgenography of the bladder; a rare image.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 229–230.

A very interesting case of multiple calculi of the bladder is described in a man forty years of age.

At operation 17 phosphatic stones were found, 12 of which were the size of a pigeon's egg and 5 somewhat smaller. A cross section of one of the larger stones revealed that the central portion of the calculus consisted of a blue stained, oily substance which on chemical analysis was found to be gomenol stained with methylene blue. The bacteriological analysis showed the presence of active staphylococci.

Many years previously the patient had received bladder injections of gomenol and at the same time methylene blue pills were given per os. It is most probable that the air bubbles which formed at the time of the injection of the gomenol became stained with the methylene blue and later resulted in the formation of the stones.

The presence of active staphylococci within the oily substance of the stones so many years later is exceedingly interesting since it dissipates all illusions with regard to the antiseptic value of gomenol.—*T. Leucutia.*

SKELETAL SYSTEM

RITTER, HENRY H. Fractures of the carpus. *Surg., Gynec. & Obst.*, Dec., 1929, *49*, 838–842.

This is a study of 25 unselected cases of fractures of the carpal bones. It contains only two illustrations of roentgenograms, the one showing an air-injected wrist joint of a cadaver with a fracture of the scaphoid, and the other a complete backward dislocation of the distal row of carpal bones in a living subject.

The author's conclusions are as follows: (1) The scaphoid is more often damaged than

all other carpal bones. (2) Dislocation of the semilunar is frequently associated with a fracture of either the scaphoid or articular surface of the radius. (3) Osseous union in carpal fractures is the exception; fibrous union the rule. (4) Much of the disability following carpal injuries is due to intra-articular soft structure damage. (5) Early attempts at closed reduction of scaphoid fractures or semilunar dislocations should be made. (6) Failure to obtain proper reduction by closed manipulation should be followed by immediate open operation. (7) Cases of carpal fracture treated unsuccessfully by immobilization should be operated on within three months lest irreparable subsequent arthritic changes take place.—*R. S. Bromer.*

Soupault, R., Gutmann, R. S., and Bertrand, I. Un cas de myélocytomes multiples. (A case of multiple myelocytoma.) *J. de radiol. et d'electrol.*, Sept., 1929, *13*, 503–507.

A woman suffering from a pathological fracture of the right arm was seen by the authors in December, 1924. The physical examination revealed multiple tumors of the skull and the roentgenograms showed areas of rarefaction of the tables of the skull corresponding to the site of the tumors. The patient died in February, 1925, and the autopsy revealed multiple myelocytoma (mixed with plasmocytoma).

The condition is exceedingly rare and therefore the roentgenograms of the humerus and skull as well as the photographs of the vertex at the autopsy are presented.—*T. Leucutia.*

Camplani, Mario. Un caso di lussazione congenita della testa del radio. (A case of congenital dislocation of the head of the radius.) *Radiol. med.*, Nov., 1929, *16*, 1093–1100.

This case was in a man, aged thirty-eight, who came for examination because he had pain in the right elbow following an injury some six months before. He had no pain in the left elbow. Roentgen examination showed the right elbow normal but on the left the condyle of the humerus was displaced from its normal articulation with the head of the radius, the edge of the head of the radius resting against the lateral margin of the condyle. The head of the radius appeared longer than normal and the neck slenderer. The head of the radius was not the normal shape it is for receiving the condyle of the humerus but was deformed. The head of the radius did not have any articular attachment to the ulna. There was apparently no joint cartilage. The ulna and humerus were shorter than normal; the diaphysis of the radius was curved. This malformation had not caused any functional disturbance as the man had been a laborer doing hard work all his life.—*A. G. Morgan.*

Colp, Ralph, and Findlay, Robert T. Fractures of the pelvis. *Surg., Gynec. & Obst.*, Dec., 1929, *49*, 847–853.

This is a review of 35 consecutive cases of pelvic fractures admitted to the Beekman Street Hospital, New York, from January 1, 1925 to October 1, 1928. It is profusely illustrated with tables showing the various occupations of the patients, the nature of the trauma producing the injuries by falling, by crushing and by collision, the location of pain, tenderness and swelling, and with tracings of roentgenograms showing the various anatomical situations of the lines of fracture. There is no attempt made, however, to classify the fractures either from the standpoint of anatomical distributions or from the mechanism of occurrence.

When the patients were discharged from the hospital 21 were in excellent condition, one was in fairly good condition, one was improved, 2 were in fair condition and in 3 the result could not be accurately determined. Six of the patients died, their deaths being due to complications and the fractures of the pelvis played but a small part in the causation of death.—*R. S. Bromer.*

Fischgold, H. Fracture de l'os coxal. (Fracture of the pelvic bone.) *J. de radiol. et d'électrol.*, June, 1929, *13*, 348.

A fracture of the acetabulum with penetration of the head of the femur into the pelvis is described in a woman twenty-six years of age, who fell from a height of 3 meters. In a recent article Lenormand pointed out the frequency of occurrence of these fractures in the male (40 out of 46 cases). This case occurring in a woman is therefore of particular interest.—*T. Leucutia.*

Peirson, Edward L. Jr. Osteochondritis of the symphysis pubis. *Surg., Gynec. & Obst.*, Dec., 1929, *49*, 834–838.

Peirson believes that osteochondritis of the symphysis pubis is not an extremely rare condition but one about which there is little in the literature. The predominance of urinary symptoms in patients having this condition, and its occurrence very often as a complication of bladder surgery, usually bring such patients to the urologist who is not particularly interested in pathological changes in bone. In 3 of his 4 reported cases, the diagnosis was overlooked for a long time.

In 2 of the cases the roentgen findings were interpreted as normal. The interpretation of an infectious process in the region of the symphysis pubis is difficult because of the wide anatomical variations in the outline of the joint. In all 4 cases reported the infectious process was due, as far as could be ascertained, to a pyogenic infection and not to tuberculosis. The 4 cases occurred within a year. If the possibility of the condition is considered when the case is examined, the roentgen diagnosis is not likely to be overlooked. One case followed a simple suprapubic prostatectomy; a second one came either from the same cause or as a result of a general septic process; a third case was apparently primary in nature, and a fourth case probably followed an operation for inguinal hernia.

The most constant symptom was pain in the region of the symphysis pubis radiating down the legs and made worse by motion. One case showed marked urinary symptoms. Definite tenderness was present over the pubis in every case; other signs of a local inflammatory process in the region of the symphysis may or may not be present.

The roentgen picture in one case revealed apparent fusion of the symphysis and considerable bone reaction around it without bone destruction. In another case the pubic bone showed some irregularity in the symphysis, and also some asymmetry and disalignment of the symphysis with the sacrum, which was regarded only as an anatomical variation. The third case showed definite osteomyelitis of the symphysis. The fourth case showed slight irregularity of the outline of the pubic bone, adjacent to the symphysis, which was regarded as within normal limits. As the cartilage seems to be first involved the roentgen findings are not apt to be definite.—*R. S. Bromer.*

Piffault, and Barreau. Arthropathie syphilitique du genou. (Syphilitic arthropathy of the knee.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 241–243.

The roentgenograms of the knee of a patient sixty-four years of age who for a period of three months had developed a gradual swelling of the knee are briefly discussed.

The changes consisted chiefly in a periostitis of the internal aspect of the lower end of the femur, with a thickening of the internal portion of the upper end of the tibia and proliferations and foreign bodies within the joint space.

Diagnosis of syphilis was made. This was supported by a history of chancre twenty-five years before, by the coexistence of superficial glossitis and leucoplakia and by the positive Wassermann and Hecht tests.—*T. Leucutia.*

Piccinino, G. Distrofia del V metacarpo. (Dystrophy of the fifth metacarpal.) *Radiol. med.*, Nov., 1929, *16*, 1110–1113.

A girl of eleven who had been a very ardent student of the violin began to have pain at the base of the 5th metacarpal of the left hand and difficulty of movement which obliged her to give up her violin practice. The finger was visibly shorter than the one on the right. On rest the pain stopped but the difficulty in movement persisted. Roentgen examination showed shortening of the finger entirely at the expense of the metacarpal; the distal end of the bone was enlarged. The neck of the metacarpal had almost disappeared, the joint cartilage was thinner than normal and irregular in form; in the spongy bone small zones of rarefaction alternated with trabeculae that were denser than normal. The cortex was a little thickened, particularly on the radial side, the head was flattened and enlarged transversely and displaced toward the palmo-radial side. The interarticular space was normal in width and only enlarged transversely. There were no changes elsewhere in the skeleton. Rest and general tonic treatment was recommended. When she was seen a year later the bone changes were the same except that the head of the metacarpal was still more flattened and protruded still more toward the radial side; the pain had stopped and the child was

able to take up her violin work again, though there was some interference with movement of the finger.

From the clinical and roentgen resemblance of this case to the forms of meta-epiphysitis of adolescence, particularly Köhler's disease of the 2d metatarsal, the author thinks this is a new localization of these osteochondral dystrophies. He thinks this localization may have been caused by the child's work on the violin begun at such an early age.—*A. S. Morgan.*

Sisk, J. Newton. Bone tumors. *Radiology*, August, 1929, *13*, 115–120.

It is the author's opinion that treatment of bone tumors in the past has been undertaken in most cases late in the disease when it has probably already become systemic. Indifference of general practitioners to the serious probabilities arising from apparently trivial early history of bone lesions often delays correct diagnosis and treatment. Confusion of terminology and classification has interfered for many years with progress in the management of bone diseases. Since malignant bone tumors do not usually fit any simple diagnostic scheme of classification, the best analysis of a bone tumor the roentgenologist can give is an accurate opinion as to whether it is benign or malignant. The author feels that the value of radiation therapy is as yet undetermined and conclusions concerning it should be suspended until further evidence has been reported.—*J. D. Camp.*

Roederer, C. Difficultés de diagnostic radiologique des ostéites fibreuses. (Difficulties of radiological diagnosis of osteitis fibrosa.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1929, *17*, 224–226.

Two cases are briefly described in order to show that the diagnosis of osteitis fibrosa often encounters insurmountable difficulties. Both cases at the beginning presented a lesion of the femur just above the knee which had the appearance of a bone cyst. An operation eighteen months later on one of the cases revealed osteitis fibrosa, while the other case evolved into a bone sarcoma with a fatal outcome.

Babok's opinion that the "final radiologic formula" of malignant bone tumors is yet to be found is endorsed.—*T. Leucutia.*

ROENTGEN AND RADIUM THERAPY

Delherm, L., and Beau, Henri. La diathermie et la radiothérapie dans le traitement de l'artérite oblitérante. (Diathermy and radiotherapy in the treatment of arteritis obliterans.) *J. de radiol. et d'électrol.*, July, 1929, *13*, 383–388.

Diathermy in the treatment of arteritis obliterans has been used by Delherm and Laquerrière since 1907. The following technique is advised: One electrode is placed on the gluteal region and the second on the foot and treatment is started. As soon as the patient complains of pain in the region of the ankle the electrode of the foot is moved to the calf and treatment is continued until a complete dose is given. At the same time the foot and the ankle are exposed to infra-red rays or electric baths.

In certain instances the treatment is combined with roentgen irradiation of the dorsolumbar spine (between the second dorsal and fifth lumbar), with 25 cm. spark gap, 5 mm. Al, 25 cm. skin target distance, 300 to 400 R per sitting, one to three sittings per week, 900 to 1600 R per series, repeated at two to three weeks' intervals.—*T. Leucutia.*

Finzi, N. S., and Levitt, W. M. X-rays in the treatment of malignant disease. *Acta radiol.*, 1929, *10*, 409–420.

Certain factors that have an effect on the results of deep roentgen therapy in malignant disease are discussed. The results reported in the literature by different authorities have varied greatly. As a probable explanation for these wide variations attention is called to the great number of variable factors in roentgen therapeutic technique, and the almost complete lack of any knowledge heretofore which would serve as a guide in choosing between the different possibilities, for example variation in quality of rays, in filtration, intensity, time, etc. The result has been the development of a very great number of different techniques for the treatment of each condition, and a complete lack of uniformity in the practice of different clinics.

The technique used and the results obtained during the past 4 years in the Radiotherapeutic Research Department of St. Bartholomew's Hospital are briefly described. Very encouraging results have been obtained in malignant disease in the upper air passages and

uterus, but not in the rectum, esophagus and breast, although similar techniques are used in all cases. It is suggested that different techniques may be required in different types of malignant disease and reference is made in this connection to the possible variation in the threshold intensity for different types of epithelium.

The authors conclude that complete disappearance of a malignant growth, either sarcoma or carcinoma, may in some cases be brought about by roentgen treatment. This apparent cure may last for several years; it is not yet certain whether it may be permanent. —*A. G. Morgan.*

ASTIER, A. Hypertrophie symétrique des glandes parotides traitée par la radiothérapie. Guérison. (Symmetrical hypertrophy of the parotid glands treated by roentgen therapy; healing.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1929, *17*, 201–205.

A case of bilateral swelling of the parotid glands, occurring in a woman forty-four years of age, and lasting for a period of six months, is described in detail. The case is interesting both from the diagnostic and therapeutic standpoint.

From the diagnostic standpoint a differentiation must be made from Mikulicz's disease, leucemic manifestations and the so-called Dalché's hyper-parotidies.

From a therapeutic standpoint the great radiosensitivity of the tumor (diminution in size following the application of only 3 H over each parotid) was noteworthy.

Although no accurate diagnosis could be made, the opinion is expressed that the condition most probably belonged to the hyperparotid group and that it developed on an endocrine basis (menopause).—*T. Leucutia.*

AMALRIC, and COUREAUD. Cancer de la langue. Évidement ganglionnaire unilatéral sous-maxillaire et carotidien. Curiepuncture linguale. Guérison depuis 33 mois. (Cancer of the tongue; unilateral dissection of the submaxillary and carotid lymph nodes; radium needling of the tongue; healing after thirty-three months.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1929, *17*, 197–200.

A case of carcinoma of the tongue with extensive metastases to the submaxillary and carotid lymph nodes, occurring in a man sixty-two years of age, is briefly described. The patient was treated by the combination of surgery and radium, and he has remained well for a period of thirty-three months.

The procedure consisted first in the surgical dissection of the submaxillary and carotid lymph nodes on the affected side. Two weeks later, the primary lesion of the tongue was treated by local application of radium (under novacain anesthesia). Eight radium needles were implanted into the tongue in a circle around the lesion and left in position for a period of seven days, that is, 168 hours. The total dose administered amounted to 25 millicuries-destroyed (0.5 mm. platinum filter).

The case is described as an example of the most rational method of treatment of carcinoma of the tongue with metastases to the adjacent lymph nodes.—*T. Leucutia.*

GASK, G. E., and MOIR, E. D. The technique of radium treatment of carcinoma of the tongue and mouth. *Acta radiol.*, 1929, *10*, 403–408.

The method of examination of the patient and of estimation of the radium dosage are described, and emphasis placed on the necessity of eliminating oral sepsis. The methods of anesthesia, general and local, are described. The primary growth is usually treated by interstitial irradiation with radium needles or radon seeds, the period varying from six to fourteen days. The gland areas are treated with radium needles according to a standardized arrangement, covering the submental, submaxillary and sterno-mastoid regions. The needles are left in position for seven to ten days. When the glands are large they are first irradiated with an external radium collar of Columbia paste. The patients are systematically watched, and a second treatment is given as soon as it becomes apparent that the first has been inadequate. Antisyphilitic treatment is given whenever the Wassermann reaction is positive. No statistics are given, as the treatment was not systematized until 1928.—*A. G. Morgan.*

HARMER, DOUGLAS. Radium treatment of malignant disease of the upper air passages. *Acta radiol.*, 1929, *10*, 362–378.

The authors, after fifteen years' experience, believe that radium alone, or radium com-

bined with surgery, gives better results in malignant disease of the upper air passages than surgery alone. Implantation of radium needles for a long period is used whenever possible. Malignant growths of the nasal fossae or accessory sinuses are approached in various ways, usually through the palate. The results in sarcoma have been very good, 6 out of 13 patients having remained alive for periods of three to eight years. The results in endothelioma have not been so good, only 2 out of 13 patients having survived for more than five years. Among 34 cases of carcinoma, 8 patients have survived for from six months to six years; nearly all of these were inoperable cases. Malignant growths of the tonsils and neighborhood have been treated with buried radium needles. Improvement has been brought about but very few patients have been cured. Carcinoma inside the larynx has been treated by implanting radium needles through a window in the thyroid cartilage. The results have been very good in 12 of 14 early cases and in 2 of 9 advanced cases.—*A. G. Morgan.*

Fraticelli, A. Sulla terapia radiologica della pertosse. (Roentgen treatment of whooping-cough.) *Radiol. med.*, Nov., 1929, *16*, 1100–1109.

Fraticelli describes 42 cases of whooping-cough treated with roentgen rays. The treatment was of unquestioned value and it may even be said to be the only treatment of this disease which brings about a rapid and distinct change and often complete recovery in a few days. The first symptom to yield is the vomiting. The night after the first irradiation the child rests well. The attacks of coughing become shorter and less intense within twenty-four hours. The results are much better if the treatment is given within the first few days of the illness. The least satisfactory results were obtained in a group of cases which were not treated until after 20 days from the beginning of the illness. But even if the patient is not sent to the roentgenologist until some time after the disease begins the roentgen treatment should be tried, for it helps the vomiting and restlessness and decreases the number and severity of the attacks. Not one of the author's patients had any complications but he does not think that justifies his claiming that roentgen treatment will always prevent the complications of whooping-cough.

The technique should be adapted as far as possible to the individual case, taking into account the age and general condition of the patient and his physical development, particularly the circumference of the thorax and the percentage depth dose that can be made to act on the lungs and anterior mediastinum. For children between four and seven years of age and of normal development, and this is the age at which whooping-cough most frequently occurs, he found that a dose of 135 r was enough, but if the illness has lasted more than twenty days the percentage depth dose must be increased. But some of the patients who were given a smaller beginning dose than they should have been given developed a remarkable resistance to the rays on later treatments even with larger doses. So the proper dosage should be used in the beginning. In most of the patients treated early in the disease two applications were sufficient. In some three were given. —*A. G. Morgan.*

Keynes, Geoffrey. The treatment of primary carcinoma of the breast with radium. *Acta radiol.*, 1929, *10*, 393–402.

The author has concluded within the past five years that treatment of primary carcinoma of the breast with radium needles is preferable to operation. A total of 90 patients has been treated from August, 1924 to August, 1929, many of them having operable tumors. The dose used is relatively small, up to 100 mg., and the time of exposure long, seven days or more. The radium is distributed in the primary growth and in the lymphatic drainage, including the pectoral area, axilla, infraclavicular, supraclavicular and intercostal spaces. The needles are inserted through small stab wounds under gas and oxygen anesthesia.

The effect on the primary growth is usually complete after four months; if the tumor has not completely disappeared by this time further treatment, operative or radiological, may have to be considered. No extensive operation is ever needed. Usually no operation at all is performed. Enlarged lymph glands respond well to radium and usually disappear. Histological proof of the nature of the growth was obtained in the first 50 cases, but no specimen is now taken, as it has been found that cutting

into the tumor sometimes results in an implantation growth. Histological examination after treatment in some cases has demonstrated partial or complete destruction of the carcinoma by radium.

Of the 90 cases treated 23 are recent; of the remaining 67, 41 have been operable and 26 inoperable. The results have been good in 45 of the 67, 12 of the 45 being inoperable. Patients have remained apparently cured up to 4½ years after treatment.—*A. G. Morgan.*

Barris, J. D., and Donaldson, M. Radiological work in the gynaecological department, St. Bartholomew's Hospital. *Acta radiol.*, 1929, *10*, 379–392.

This paper describes the work that has been done during the past eight years, chiefly in the treatment of carcinoma of the cervix. At first a large dose was used for a short period. Since 1924 a smaller dose, usually about 45 mg. has been used, needles being buried around the growth and left in position for six days. In addition patients are being treated with roentgen rays, and some with intra-abdominal radium. The details of the intra-abdominal method are described. Since 1921 a total of 202 patients have been treated. The local results have been uniformly good, and recurrences in the cervix are rarely seen. The patients who die have metastatic growths in the iliac glands.

The treatment of other malignant conditions in gynecology is briefly discussed. In carcinoma of the vulva the authors are using quite low intensities, such as 15 mg. distributed in 10 or more needles, kept in position from two to three weeks. The primary effect of this treatment on the growths is remarkable, but it is too soon to say what the final results will be. In nonmalignant conditions, such as hemorrhage during the menopause and small fibroids, the authors think that 50 mg. radium used for seventy-two hours is more effective than a larger dose used for twenty-four hours.—*A. G. Morgan.*

Vorlaender, K. F. Report of the cases of cancer treated at the Freiburg Gynecological Clinic with injections of cancisal and anabol. *Strahlentherapie*, 1929, *33*, 221–242.

Opitz tried to cure cancer by influencing cell metabolism, either by injuring the cancer cells directly or by acting on the surrounding tissues. The first preparation that he tried was cancisal, which is a combination of adrenalin-cholin with a metal catalyzer and a pigment. This preparation destroyed experimental cancer in animals but in man it produced very serious reactions on account of which it had to be given up. It was then combined with injections of anabol, which is an organic acid preparation. Thirty-six cases were given combined cancisal-anabol treatment in association with irradiation. After two and a half to three years 5 of the patients are still alive and free of symptoms, or 14 per cent. The five years necessary to pronounce them cured have not yet passed. The histories of the 5 living patients are given and also histories of 5 patients treated by irradiation and injections of anabol alone.

On the whole, the patients bore the treatment without any injury and with improvement in the general condition, with cessation of pain, hemorrhage and discharge and increased appetite and feeling of strength. In some particularly favorable cases the tumor also appeared to be affected to some extent. The effect seems to have been about equal to that obtained by other measures used to supplement radiotherapy, such as arsenic, blood transfusion, serum treatment, treatment with tumor extracts, etc.—*A. G. Morgan.*

McGlinn, John A. Cancer of the cervix complicating pregnancy. *Am. J. Obst. & Gynec.*, Oct., 1929, *18*, 592–597.

The author reports two cases of cancer of the cervix, complicating pregnancy, one in early pregnancy, properly diagnosed, the other in late pregnancy, mistakenly diagnosed. The first case presented some interesting phases. (1) The cancer undoubtedly antedated the pregnancy in a fairly young primipara (thirty-one years old). (2) Cauterization and radium apparently cured the cancer of the cervix, yet pelvic metastases occurred later without any return of the local condition. (3) Radium, by its action on the circulation of the cord and the placenta, caused the death of the fetus.

In the second case a mistaken diagnosis of placenta previa was made, when the patient developed vaginal bleeding late in pregnancy. McGlinn discusses fully the prognosis both for the mother and child and the methods of treatment. In regard to irradiation he states the following conclusions:

1. Irradiation of pregnant animals or human beings is a procedure extremely dangerous to the health of the offspring concerned (63.3 per cent defective), and in the case of human beings ought not be undertaken unless existing pregnancies are to be terminated artificially prior to the period of viability of the child.

2. As yet, it cannot be definitely stated that preconception maternal pelvic radium application or roentgen irradiation is or is not prejudicial to the health of the subsequent child.

McGlinn thinks the effects on the child in pre- and postconception irradiation is about the most important question to be solved at the present time, and he urges every one to carefully record their experience so that conclusions based on a study of a large series of cases can be drawn.—*R. S. Bromer.*

Goldstein, Leopold, and Murphy, Douglas P. Microcephalic idiocy following radium therapy for uterine cancer during pregnancy. *Am. J. Obst. & Gynec.*, August, 1929, *18*, 189–195.

The authors state that microcephalic idiocy as a distinct entity is a rare condition. Probably not more than one out of every hundred idiots is microcephalic. Nevertheless, it appears to be the most common single developmental disturbance observed in children born following therapeutic postconception pelvic irradiation by either radium or the roentgen ray.

They report a case of microcephalic idiocy, occurring after postconception radium therapy for several reasons. Heretofore few such cases have been recorded. The child described has been observed for a longer period than any of the microcephalic idiots previously reported. They have been able to secure exceptionally complete records of the physical and mental development of the child. It is also an interesting fact that this is the second case of microcephalic idiocy occurring after irradiation for carcinoma of the cervix, complicating pregnancy, to be reported.

The case history is presented in great detail. The patient, born June 22, 1916, was at the time of the last examination twelve years old. Psychological, neurological and complete physical examinations were made. In the discussion of the case, the authors conclude that no pregnancy should be allowed to continue to term when roentgen or radium therapy has been employed after conception. They base this opinion on the frequency of microcephalic idiocy after postconception irradiation, and upon the condition of the child described in this report.—*R. S. Bromer.*

Murphy, Douglas P. The outcome of 625 pregnancies in women subjected to pelvic radium or roentgen irradiation. *Am. J. Obst. & Gynec.*, Aug., 1929, *18*, 179–187.

This paper is based on a study of the outcome of 625 pregnancies occurring in women who were subjected to pelvic radium therapy or roentgen irradiation either before or after conception took place. His data were secured from a review of the literature and from answers to a questionnaire sent to more than 1700 leading gynecologists and radiologists in the United States. In every case the treatments were directed toward the pelvic organs, though in one or two cases the pelvic irradiation was employed for the purpose of inducing sterility because of the existence of a systemic disease.

He discusses and analyzes the data under several headings including the influence of irradiation upon the health of the child, the frequency of unhealthy children, the influence of the time of treatment upon child health, the study of children born following maternal preconception pelvic irradiation and those born following postconception irradiation. His conclusions follow:

Irradiation before conception may be followed by the birth of unhealthy or defective children. It cannot be definitely stated that such maternal treatment has a detrimental influence on the health of subsequent children.

Irradiation of the pregnant woman is extremely likely to be followed by the birth of seriously defective offspring. The frequency of these defects and their conformity to a type, of which microcephaly is the most common, strongly suggest that they are the result of irradiation received by the embryo in utero.

It is believed that diagnostic curettage should always precede pelvic radiotherapy, in order to avoid possible irradiation of a growing embryo.

The conclusion is reached that the pregnant uterus should never be subjected to radiotherapeutic exposures.

It is further deemed advisable that should a growing embryo unwittingly be irradiated and

its existence later be discovered, such a pregnancy should be terminated at the earliest possible moment.—*R. S. Bromer.*

POLAK, JOHN C. A preliminary report on temporary roentgen-ray castration in the treatment of subacute adnexal inflammation. *Am. J. Obst. & Gynec.*, Oct., 1929, *18*, 580–586.

The author reports the results of the treatment of a series of 34 cases of acute adnexal infections which were treated during the past five years. In this series there were 16 cases of gonorrheal origin, 10 gave histories of previous abortions or labor, belonging to the puerperal class, and 8 were classed in the tuberculous group. The periods of amenorrhea lasted from four months to one year; in all the patients the pathologic exudate in the pelvis disappeared, the uterus became mobile, and the actual adnexal masses were easily defined. Few needed operation and it was surprising to note in these cases how free the pelvis was of adhesions and how easily the existing ones were separated. Of the 7 women operated upon, all had retro-displacements with adnexa in the cul-de-sac. The other 27 had the uterus forward and have had symptomatic cures. In no cases has menstruation failed to reappear, and one woman has become pregnant.

The author does not believe these same results can be secured by rest and time alone without the use of the roentgen ray for the reason that premenstrual, pelvic and abdominal soreness have been a more or less constant finding in conservatively cured cases. Without the use of irradiation, this symptom has occurred right up to the time of the menopause, when apparently all of the subjective symptons seem to disappear. In the cases treated by the roentgen ray the premenstrual and peritoneal soreness was absent. The value of the roentgen ray has been best demonstrated in patients with tuberculous salpingitis, peritoneal extension, and persistent elevation of temperature. These patients ordinarily show temperature reactions at each menstrual period, they usually have leucopenia and a low sedimentation time. Temporary roentgen sterilization changed this picture in these women and allowed hygienic and dietetic measures to do their work without handicap.

Four cases are reported in detail. The technique of the roentgen-ray exposures as used by Dr. A. L. L. Bell is briefly as follows:

The dosage necessarily varies in different cases owing to the variation in the distance of the ovaries from the anterior abdominal wall, and also their distance from the skin surface posteriorly. The object of the treatment is to apply to the ovaries a dose of about 215 to 230 electrostatic R-units (Duane-Glasser), using 180 to 185 kv. and a filtration of 0.5 mm. Cu and 1 mm. Al. In using two areas, one anterior and the other posterior, the dosage is calculated according to the depth of the ovary from the surface of each area. Thus in a given case, if the ovary receives a 35 per cent depth dose through one area, and a 33 per cent depth dose through the other, a total skin dose of 320 R-units is given of which 217.6 R-units reach the ovary. These doses are usually administered on successive days but may be given at one time. No reactions from these doses have been noted. In some cases where the infection was particularly active the treatments were divided so that only 50 R-units were applied at one time. This dose of 215 to 230 R-units is not repeated for at least two mo ths, or until after the second menstruation following the first treatment. This dosage has also never caused any amenorrhea.—*R. S. Bromer.*

WATERS, CHARLES A. Radiation and its uses in the treatment of urologic neoplasms. *Radiology*, August, 1929, *13*, 109–114.

This paper is based on the results of a critical statistical survey of a large series of malignant genitourinary tumors of all kinds. Statistics have been omitted. The rôle played by radium and deep roentgen therapy in the treatment of genitourinary neoplasms is presented briefly, and the author gives his methods and opinions of treating these tumors.

Radical operative removal of kidney tumors is the method of choice. After such a radical removal it has been the custom of the author to irradiate the abdominal and thoracic aortic glands and the site of the operation with deep roentgen therapy. If, at the time of operation, it is found impossible to remove all of the malignant tissue, radium needles are inserted and often radium element.

Metastases following carcinoma of the kidney occur first in the lungs and then in the bones. In a large percentage of pulmonary

metastases, deep roentgen therapy will often cause a rapid disappearance, only to recur, however, in some other portion of the body. In perirenal and retroperitoneal tumors, which are usually sarcomatous, the use of radium and deep roentgen therapy has proved of great value. This type of tumor is not infrequent in children.

Tumors of the ureter are highly resistant to radiation of any type, and when implantation or metastasis in the ureter has occurred the prognosis is extremely bad; the patient usually dies before any benefit can be obtained from the radiation.

The location of a tumor in the bladder plays an important rôle in its successful treatment. In papillary carcinomata, especially the non-infiltrating or superficial infiltrating type, a combination of fulguration and applications of radium, employing a cystoscopic radium applicator, has proved satisfactory, but in a large majority of these cases it is extremely difficult to determine whether a tumor is superficially infiltrating or not. If it is, it has been the author's method to supplement fulguration and radium with deep roentgen therapy. In the infiltrating carcinoma with ulcerations in the bladder this has been the method of choice. When the tumor is so situated in the bladder that it can be resected radically, such is the method of choice.

The amount of radium given should vary with the individual case. In small tumors 600 to 1200 mg. may be sufficient after the pedunculated portion of the tumor has been destroyed. The application of 600 mg. of radium to the pedicle or base of the tumor generally suffices. In large tumors much more may be necessary, and it has been found that it is well to alternate radium with deep roentgen therapy.

Only the cases of carcinoma of the prostate that cannot be radically and completely removed surgically, with hope of cure, should be treated by deep roentgen therapy and radium. Patients are treated on alternate days with radium and roentgen rays, rarely being given both the same day. The radium is given, in rotation, through the rectum, urethra and bladder. This is done in order to avoid a burn. The number of radium applications varies with each case and the extent of the involvement plus the idiosynerasies of that particular patient. As a rule, the patient will stand from 400 to 600 mg. per urethra, from 400 to 800 mg. through the bladder, and from 800 to 1200 mg. through the rectum. The deep roentgen treatments are given on the days the patient does not receive radium. After the patient has completed the course of radium treatments, daily roentgen treatments are given.—*J. D. Camp.*

Gordon-Watson, Charles. Radium treatment of carcinoma of the rectum. *Acta radiol.*, 1929, *10*, 345–361.

The author considers the relation of radium treatment to operation in rectal carcinoma. He concludes that radium should be used chiefly for inoperable and borderline cases, and then only in conjunction with surgery. He gives an account of the indications for radium, together with technique and dosage. Neumann's method of irradiation with needles after exposure of the growth from the perineum is described in detail, with diagrams showing the distribution of the needles. Other methods are considered more briefly, namely, intra-abdominal, intra-rectal, through the vagina, through the skin of the perineum, surface radiation on Columbia wax, and irradiation with a bomb at a distance. The author has in a few cases used irradiation as a preliminary to excision, but the method is still under trial. Some patients have also been treated for recurrence after operation. He has treated 65 patients in 4 1/2 years and on the whole the results have been encouraging. The author is satisfied that great alleviation can be brought about in advanced cases but at present he prefers operation in operable cases.—*A. G. Morgan.*

Boner, L. Efficacité de la radiothérapie dans sept cas d'ostéite non tuberculeuse. (Efficacy of radiotherapy in seven cases of non-tuberculous osteitis.) *J. de radiol. et d'électrol.*, June, 1929, *13*, 344–345.

Seven cases of inflammatory nontuberculous bone changes of the phalanges were treated by using the following technique: 16 to 20 cm. spark gap, 2 to 3 mm. Al filter, 1 to 1.5 H per sitting at weekly intervals. A healing was observed in all instances. The conclusion is reached that roentgen therapy with small doses is of the greatest aid in the treatment

of inflammatory nontuberculous bone conditions.—*T. Leucutia.*

Simons, A. Ueber Vorkommen und Bedeutung der sogenannten Wunddiphtherie als Komplikation bei Röntgen- und Radiumverbrennungen. (Occurrence and significance of so-called wound diphtheria as a complication of roentgen and radium burns.) *Acta radiol.*, 1929, *10*, 291–310.

Fourteen cases are described in which tissue necrosis followed roentgen or radium irradiation. In 8 of the cases, in addition to cocci, bacilli were demonstrated which could not be differentiated morphologically or culturally from true diphtheria bacilli, but they proved nonvirulent in animal experiment. In one case no animal experiments were made. The ulcerations infected with these bacilli usually show the clinical symptoms of surgical diphtheria. Little attention has been paid to these symptoms in roentgen necrosis, though as a rule they are marked enough so that they can be diagnosed even without bacteriological examination. These bacilli are negligible as a possible source of infection, but they may complicate and delay the healing of the necrosis. And in burns that are in themselves mild they may cause a development similar to that of severe roentgen or radium injuries. The prognosis of radiation necrosis complicated by surgical diphtheria is good. The general condition of the patient is rarely affected.

Therapeutically little can be done to influence the course of the infection. The main factor in determining the healing tendency and the extent of the subsequent cicatrization is the severity of the original burn, while the tissue destruction caused by the secondary infection is of minor importance.—*A. G. Morgan.*

Finzi, N. S. The therapeutic uses of radium applied externally. *Acta radiol.*, 1929, *10*, 332–344.

The author sketches the history of the external use of radium since 1903 and says that he was probably the first to use a large quantity at a distance in 1911. The methods of application are described, together with their use in superficial diseases, such as epithelioma, rodent ulcer and inflammatory diseases of the skin. The treatment of deep disease by external application is then described and a discussion given of the separating material, usually Columbia wax, the distance and dosage, the effects during the application and the treatment of the skin afterward.—*A. G. Morgan.*

Johnston, Zoe Allison. The use of radium in the treatment of nevi. *Radiology*, August, 1929, *13*, 169–173.

The author mentions briefly the types of nevi to be considered, other methods of treating nevi, and the experience of other workers, spending more time on the technique of treatment and end-results obtained after radium treatment. The aim of the treatment is not only to cause the disappearance of the birthmark, but to produce the least possible scarring. Radium therapy, properly applied, is beneficial in a large number of cases. It becomes a menace only when enthusiasm leads to over-dosage. Experience has taught that selection of the treatment for each individual case is important. Best results are often obtained by a combination of methods. The author concludes that radium in the treatment of the great majority of birthmarks shows a degree of usefulness varying according to individual cases that is incontestable.—*J. D. Camp.*

Rosti, E. Dell'azione dei raggi Roentgen nel lichen ruber planus. (Action of roentgen rays in lichen ruber planus.) *Radiol. med.*, Nov., 1929, *16*, 1126–1138.

The most recent theory in regard to the etiology of lichen is that it is nervous in origin; but there seems to be no certainty as to whether it is caused by a lesion of the cerebrospinal or peripheral nervous system or even of the vegetative system; nor is the mechanism of production of the skin lesions explained. Many roentgenologists and dermatologists have used radiotherapy in the treatment of lichen, irradiating the spinal column. But some of them have allowed the rays to act on the sympathetic, some on the spinal cord and some on the spinal roots, depending on their theories in regard to the cause of the disease.

The author describes 14 cases in which he used roentgen irradiation; in 13 he irradiated the sympathetic, in one the cord. All the patients had the typical skin manifestations

of lichen ruber planus. For roentgen treatment of the sympathetic he used moderately penetrating rays, 130 kv. 1 ma., 2 mm. Al filter; rays centered on the cervicodorsal region and an accessory center in the lumbodorsal region. The treatments were given in groups of three on alternate days with longer intervals between the groups. The dose was 204 r in each group of three treatments. In one case the cord was protected by a band of lead about the width of the vertebral canal. In roentgen therapy of the cord the technique used was that of Pautrier: irradiation of the whole cord from the 1st dorsal to the 5th lumbar with a total dose of 850 r for the three zones into which the spinal column was divided.

In the patients given roentgen therapy of the sympathetic there were no local or general bad effects, while in those in whom the cord was irradiated there was quite intense nausea, vomiting and headache which persisted for some time. With both methods the symptom that was affected most promptly was the pruritus. The Herxheimer reaction which was brought about in some patients was followed by improvement as it usually is. Disappearance of the eruption followed the cure of the subjective symptoms slowly; local applications of roentgen rays did not appear to accelerate it. In all the patients an intense brown pigmentation persisted for some months after the treatment.

It is impossible to say just what nerves are affected when the spinal column is irradiated. But the author is inclined to think that the improvement is due to irradiation of the sympathetic rather than of the spinal cord.—*A. G. Morgan.*

Schreus, H. Th. Carcinoma and acid-base metabolism. *Strahlentherapie*, 1929, *33*, 243–248.

In addition to direct destruction of carcinoma cells it seems to be possible to affect carcinoma to a certain extent by improving the defensive forces of the body. Recent investigation has shown that in carcinoma the reaction of the blood is shifted in the alkaline direction. This is found so constantly that there must be a connection between it and carcinoma, though just what the relation is has not yet been determined. The fact that blood pH is almost constantly increased in carcinoma can also be utilized in diagnosis.

A table is given showing the values for alkali reserve in the blood, that is the part of the carbon dioxide of the plasma that is fixed in the form of bicarbonate. This average is normal. Acid treatment decreases the alkali reserve but does not affect the pH of the blood. This explains the failure of acid treatment in carcinoma, as it does not affect the alkalosis of the blood.

Investigation has also shown that there is less difference between the pH of the blood of the arteries and veins in cancer patients than in normal subjects; this indicates an insufficient supply of oxygen in the tissues. There are some clinical observations that seem to confirm this theory, namely, the fact that the results of irradiation of cancer are improved by after-treatment at high altitudes, by increasing hemoglobin and shifting acid-base balance, and the oxygen experiments of Fischer-Wasels. These authors experimented with inspiration of oxygen and carbon dioxide, giving carbon dioxide in values of 4–5 per cent which are higher than the alveolar carbon dioxide tension in normal individuals and particularly in cancer patients. This stagnation of carbon dioxide in the albeoli and therefore in the blood would naturally decrease the pH of the blood. Direct tests of the blood reaction before and after inspiration of oxygen and carbon dioxide confirmed this. The author found that the addition of carbon dioxide to ordinary air has the same effect. He believes that the decrease of blood pH is the essential factor in the effectiveness of oxygen-carbon dioxide respiration, though Fischer-Wasels thinks it secondary. At any rate, he intends to make further therapeutic tests of this change in blood pH and if it is successful it will furnish a method of general treatment of cancer.—*A. G. Morgan.*

Meaker, Samuel R. A new uterine cannula, gas-tight, oil-tight, and self-retaining. *Am. J. Obst. & Gynec.*, August, 1929, *18*, 261–263.

Meaker describes a new uterine cannula, which is gas-tight, oil-tight and self-retaining. He describes it in detail and claims it offers many advantages, of which the following are of interest from the roentgenological point of view:

1. It gives gas-tight and oil-tight obliteration in all cases. Test pressures up to 350 mm. Hg have been used without causing regurgitation.

2. The cannula is self-retaining against any force except a strong direct outward pull. It will remain in place throughout an operation, or during such moving of the patient as may be necessary for purposes of roentgen examination.

3. The instrument is adapted to all services, irrespective of their size, shape and consistency.

4. The natural position of the uterus is not disturbed by unintentional pushing or pulling. The organ can be moved, however, by manipulation of the cannula if an alteration in its position is desired.

5. With the cannula introduced and the snare applied, the vaginal speculum may be removed. Thus only two light instruments remain in the vagina during insufflation or injections, and roentgenograms are not marred by the heavy shadow of the speculum.—*R. S. Bromer.*

OKA, MITSUTOMO. Eine neue Methode zur röntgenologischen Darstellung der Milz (Lienographie). (A new method for the roentgenologic demonstration of the spleen [lienography].) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, September, 1929, *40*, 497–501.

During the course of animal experiments with thorium-dioxide-sol (a preparation advocated recently by Blühbaum, Frik and Kalkbrenner for bronchography), the authors accidentally found that the spleen of the injected animals became visible to the roentgen rays.

In successive experiments the minimal dose of thorium-dioxide-sol necessary for the visualization of the spleen was determined and it was found that for rabbits this corresponds to 0.05 gm. per kilogram body weight, while for dogs it is 0.5 gm. per kilogram body weight.

The intravenous injection of a large dose of thorium-dioxide-sol produced rapid death of the experimental animal. The single minimum lethal dose for rabbits is 0.3 to 0.4 gm. and for dogs 0.3 gm. per kilogram body weight. (Note: In dogs, the minimum dose necessary for the visualization of the spleen is larger than the single minimum lethal dose.) However, if the dose is injected in fractions with corresponding intervals between the injections, the tolerance limit may be increased to 0.5 gm. per kilogram body weight for rabbits and to 1.0 gm. per kilogram body weight for rabbits and to 1.0 gm. per kilogram body weight for dogs. Of course, the injection should be done as slowly as possible.

Since the injection of thorium-dioxide-sol has a tendency to produce hemolysis, the addition of a 5 to 10 per cent hypertonic dextrose solution is of considerable aid.

The method cannot as yet be declared of clinical value. Further investigations are necessary in order to accurately determine the nature of the process occurring within the spleen. This will also aid in making the method less harmful.

It is, nevertheless, of singular interest that solid organs such as the spleen can be made visible to roentgen rays by the injection of contrast media.—*T. Leucutia.*

HESS, P. Die Erythembreite von Röntgenstrahlen verschiedener Wellenlängen. (The extent of the erythema reaction produced by roentgen rays of various wave lengths.) *Strahlentherapie*, 1929, *33*, 721–731.

The author has continued his well-known experiments on the influence of radiation quality upon the erythema reaction. The physical doses were measured carefully with the Küstner instrument. Various radiation qualities, eight in all, were used from 185 kv., 1 mm. Cu filter down to 9 kv. unfiltered. The fields were 1.5×1.5 cm. The skin reaction was judged carefully by means of the Schall-Alius erythema meter.

The doses were applied in amounts of 60 to 160 per cent of a skin unit dose, which equals 700 r-units. These doses produced a uniform increase of the reaction in the first and second reaction wave. The extent of the erythema of all radiation qualities for various persons went from degree 2 to degree 15 of the erythema meter used. For the erythema dose proper individual variations in the reaction extend from degree 5 to degree 10, independent of the wave length. Borderline rays show a milder reaction which disappears. but otherwise their effect is the same as that of the roentgen rays.—*Otto Glasser.*

Murphy, Douglas P. Radium sterilization of the female albino rat (*Mus norvegicus*). *Surg., Gynec. & Obst.*, Oct., 1929, *49*, 440–446.

This is part of a study by the Gynecean Hospital Institute of Gynecologic Research of the University of Pennsylvania to determine the effects of pelvic irradiation in women upon the health and development of subsequent offspring. Certain phases of the investigation have already been published. In conjunction with the clinical studies, animal experiments upon the female albino rat are being conducted. The present paper deals with the amount of radium exposure necessary to sterilize the female rat permanently.

Permanent sterilizing radium exposure is that amount of irradiation necessary to inhibit reproduction in the rat for at least four months, which time is estimated to be the equivalent of 120 months or ten years in the human being. In this study 128 albino rats were used. They were virgin rats at the optimum breeding age of 120 days. The methods of housing and feeding the animals is described.

Irradiation was carried out by the use of approximately 500 mc. of radon contained in a capsule which was securely fastened to the back of the rat over the ovary. Each ovary was irradiated individually. Varying exposures ranging from 200 to 650 mc-hr. over each ovary were used. The animals were mated fourteen days after irradiation. This mating time was selected as offering the best possibility of securing the maximum effect of the radiation, and to prevent the fertilization of ova in the oviducts at the time of irradiation.

In these experiments 34 animals died as the result of the irradiation. Of the remaining 94 animals 41 per cent remained sterile at the end of four months. Of the animals receiving less than 450 mc-hr. over each ovary only 14 per cent remained sterile, while exposure of greater than this resulted in 74 per cent permanent sterility.

The author concludes that with the technique and the amount of radiation employed it is not possible to sterilize 100 per cent of the animals but that radium exposures in amounts not quite large enough to kill the animals will probably sterilize between 60 and 75 per cent of them.—*Karl Kornblum.*

Sauter, F. Intensitätsmessungen and C-G-S-System. (Measurements of intensity in relation to the C-G-S system.) *Strahlentherapie*, 1929, *33*, 560.

The author attempts to calculate some data expressing the current intensity units "1 r" and "1 H" in absolute energy by using experimental data of various authors. He finds that the amount of energy for "1 r" decreases with increasing wave length; it is about 1 to 5×10^3 erg for the radiation qualities commonly used. For "1 H" the amount of energy decreases rapidly with increasing wave length and amounts to about 1 to 1.5×10^5 erg. Further work on this question is desirable, especially with monochromatic beams.—*Otto Glasser.*

Jaeger, R. Ein neues Dosismesserprinzip Kompensationsmethode mit regelbarem Stromnormal. (A new dosimeter principle; compensation method with variable current standard.) *Strahlentherapie*, 1929, *33*, 542–550.

Jaeger, the associate of Behnken at the Reichsanstalt, describes a zero method to balance the current produced by roentgen rays in a large air ionization chamber against that of a variable uranium standard; an electrometer is used as the zero instrument. When compensation is reached, and if the chamber constants are known, the effective intensity in the air chamber can be read directly in r-units per second on the scale of the instrument. The current of the maximum standard can be varied in wide limits ($0\text{–}1\times10^{-10}$ and $0\text{–}3\times10^{-10}$ ampere) because of its ingenious construction.—*Otto Glasser.*

Kelen, B. Die Bedeutung der Absorptionskoeffizienton der Röntgenstrahlen. (The meaning of the coefficient of absorption of roentgen rays.) *Strahlentherapie*, 1929, *33*, 748–759.

The meaning of the exponential law of absorption of roentgen rays in matter is explained by citing well-known practical examples, such as the calculation of interest and compound interest, decay of radioactive products, etc., for which the same law holds. The significance of the coefficient of absorption and the half-value layer is discussed.—*Otto Glasser.*

Schaefer, W., and Witte, E. Weitere Untersuchungen über die Röntgenstrahlung der Lenardröhre. (Further research on the roentgen radiation of the Lenard tube.) *Strahlentherapie*, 1929, *33*, 578–581.

The authors examined the amount of primary roentgen rays of a Lenard cathode-ray tube (Phoenix Co.) at 35 cm. distance; 70, 110 and 150 kv. by means of a Küstner soft ray chamber and absorption in cellon; at this distance cathode rays do not enter the chamber. A wide spectrum of roentgen rays was found. Since a large amount of roentgen rays is produced by these tubes in a short time, it is suggested that some tubes be constructed for introduction into body cavities. Proper filtration and diaphragm permit wide variation in the size of the area and of quality.—*Otto Glasser.*

Baensch, W., and Finsterbusch, R. Über die therapeutischen Anwendungsmoglichkeiten von Kathodenstrahlen. (The therapeutic applications of cathode rays.) *Strahlentherapie*, 1929, *33*, 399–434.

The authors examined the cathode-ray beam of an improved Lenard tube of the Phoenix works by an ionization method, especially in regard to the relative amounts of cathode rays and roentgen rays. By magnetically deflecting the cathode rays they find that for the distances used in their biological and clinical experiments (4, 5 and 6 cm.) the relative amount of cathode rays is considerably higher than that of the roentgen rays. It decreases, however, with the distance and is practically 0 at 10 cm. The luminescence of a series of crystals is then compared for cathode rays, roentgen rays and ultraviolet. The authors report the results of their extended biological experiments with cathode rays; they show that the rays have a specific action upon a number of plants, that they kill bacteria in small doses, and that they have a decided destructive effect upon animal tissue. In the therapeutic use of cathode rays (95 kv., 2 ma., 5 cm. distance, 15 sec. exposure) beneficial results have been observed in canceroids, lupus exulcerans, chronic eczema; less favorable effects in infected wounds, lupus tuberosus and lupus carcinoma.—*Otto Glasser.*

Feldweg, P. Können Röntgenstrahlen ohne dauernde Messung exakt dosiert werden? (Can the dose of roentgen rays be accurately determined without continuous measurements?) *Strahlentherapie*, 1929, *33*, 574–577.

The author recommends continuous control of the applied dosage, since various factors such as replacing of old valve tubes by new ones, humid weather, etc., cause changes in the applied dose.—*Otto Glasser.*

Habs, H., Hase, H., and Küstner, H. Der praktische Weg zur Erzeugung einheitlicher Strahlenqualitäten in der Hauttherapie. (A practical method to produce uniform radiation qualities in skin therapy.) *Strahlentherapie*, 1929, *33*, 732–747.

Measurements of the thickness of the wall of various roentgen tubes showed variations from 0.4 to 1.4 mm. Even within 7 cm.^{2} of the same tube there was 33 per cent variation in thickness. The absorption in glass samples of such tubes and in aluminum was studied with the radiation of a Lindemann tube for voltages between 20 and 100 kv. It was found that in almost every instance the glass samples absorbed the rays to the same extent as an equal thickness of aluminum. It is therefore suggested in skin therapy to indicate the glass thickness in mm. Al equivalent and to add aluminum foils until in each case a uniform total thickness of 1, 2 or 3 mm., as desired, is produced. By simply measuring the thickness of the glass of the tube (a method to do so is described) the therapist may equalize the wall thickness of all his tubes by adding the required aluminum foil. In this way more uniform conditions of radiation output can be created.—*Otto Glasser.*

Spiegler, Gottfried, and Krumpel, Otto. Das Durchleuchtungslicht an verschiedenen Apparattypen mit besonderer Berücksichtigung des rotierenden Gleichrichters und des Halbwellenapparates. (The roentgenoscopic light on various types of apparatus with special consideration of the rotating rectifier and of the half-wave apparatus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, September, 1929, *40*, 513–522.

It is well known that the roentgen illumination of a fluoroscopic screen shows considerable variation in the different roentgen apparatus depending on the type of rectification. If one

places all types of rectifications in a scale according to the quality of illumination they produce on a roentgen screen, the inductor with the gas tube and the transformer with the Lilienfeld tube occupy the top of the scale, the four-valve and half-wave apparatus the bottom of the scale and the rotating rectifier a position which is intermediate between the two.

From a practical standpoint the following four requirements are important: (1) sufficient brilliance to permit of good delineation of the image on the screen; (2) maximum skin protection. In this respect, there is a similarity to the percentage depth dose in deep therapy, that is, one should aim to obtain the maximum brightness of the screen (greatest depth dose) with a minimum skin exposure; (3) sufficiently steep gradation (richness in contrast): the steeper the drop in intensity of the light, the sharper the projected image; (4) sufficient brilliance with maximum tube saving.

The light quality of the half-wave apparatus and of the rotating rectifier were analyzed in detail and it was found that the rotating rectifier leads to a greater light intensity than the half-wave apparatus, this increase being especially marked for higher filtration. The drop in intensity of the light is steeper in the half-wave apparatus when using low filter values, and it becomes equal to that of the rotating rectifier when increasing the filterage. From a practical standpoint this means that a half-wave apparatus gives excellent images in roentgenoscopy of the lungs, while for a gastrointestinal examination where the thickness of the patient (filterage) is higher, the rotating rectifier is of greater advantage. The lower value of the light intensity in the half-wave apparatus may be brought equal to that of the rotating rectifier in two ways: (*a*) by increasing the current, and (*b*) by increasing the voltage of the tube.

(*a*) The following values were found for increase of the current of the tube. If a filter of 0.3 mm. copper is used, a 2 ma. current of the rotating rectifier would have to be increased to 2.8 ma. for the half-wave apparatus, and a current of 4 ma. to 6.3 ma., in order to obtain an equal light intensity of the screen. This gives, after the necessary corrections are made, an increase of 22 per cent for the 2 ma. and 36 per cent for the 4 ma. current for the half-wave apparatus. That such an increase must lead to a greater exposure of the skin is evident.

(*b*) If, however, the light intensity is obtained by increase of the voltage of the tube, only a small increase in the voltage of the half-wave apparatus is necessary in order to get equal values, there being practically no additional exposure to the skin. Thus, for example, if the current of the tube is 2 ma. and the voltage 60 kv. effective, an increase of only 5 kv. eff. will be necessary to bring the value of the light intensity of the half-wave apparatus up to that of the rotating rectifier, while if a current of 4 ma. is used the increase would have to be 8 kv. eff.

It seems therefore that the quality of the roentgenoscopic image can be improved best by increasing the voltage. This is in contradistinction to the procedure of most roentgenologists who are rather inclined to increase the current of the tube. Of course the interposition of filters would cut out much of the soft radiation. The use of a 2 mm. instead of a 1 mm. Al filter, for example, would decrease the exposure on the surface of the skin circa 50 per cent. But such a procedure, apart from the fact that it leads, especially in roentgenoscopic examinations of the lungs, to a poorer contrast, necessitates, because of the additional thickness (created by the interposition of 1 mm. Al filter), the use of a higher milliamperage (5.4 ma. instead of 4 ma. under the above circumstances). This again leads to a 25 per cent increase in the exposure of the skin.

The above difference between the rotating rectifier and half-wave apparatus becomes still greater when using a four-valve or a continuous current apparatus. Here also, the quality of the roentgenoscopic image can be improved best by increasing the voltage.

The strain placed on the tube by a half-wave and especially by a four-valve apparatus was emphasized elsewhere by Zakovsky. The fact that in authors' experiments both the half-wave and the four-valve apparatus lead to rather quick boiling of the water in the tube when attempting to correct the difference in the intensity of the roentgenoscopic light by means of increase of the current is a further proof that also from this point of view of tube saving the roentgenoscopic image can be improved more advantageously by increase of the voltage.—*T. Leucutia.*

Crespellani, C. Rendiconto Tecnico-Statistico del lavoro compiuto nel Gabinetto Radiologico dall'anno 1923 all'anno 1928. (Work done in the roentgen room from 1923 to 1928.) *Arch. di radiol.*, May–June, 1929, *7*, 558–569.

Col. Crespellani describes the work he has done in the roentgen section of the Military Hospital in Florence from 1923 to 1928, including the installation of new apparatus for roentgen diagnosis, actinotherapy and diathermy and the organization of the roentgen service of the hospital. He gives a table showing the number of patients examined (16, 187), the number and kind of roentgen examinations made and the source from which the patients were sent. He describes the technique he used in the various examinations and shows the growing importance of the roentgen service in military hospitals.—*A. G. Morgan.*

Holzknecht, G. Sulla profilassi dei danni da Raggi X. (Prophylaxis of injury from roentgen rays.) *Arch. di radiol.*, July–Aug., 1929, *7*, 621–646.

The most frequent causes of injury from roentgen rays and the best means of prevention are outlined. Damage is often done by neglecting the filter and Kriser has devised an instrument that makes filtration compulsory because no roentgen rays will be produced if it is not inserted. A second group of injuries is caused by the current not being stopped in time. An apparatus is illustrated which carries a double alarm clock for double safety in announcing when the desired amount of irradiation has been given. Other injuries are caused by irradiation being given with softer rays than intended. In America a spherical spintherometer is used for measuring the spark gap and therefore the hardness of the rays; this is sufficiently accurate for practical purposes. Holzknecht and Spiegler have devised an instrument which may be applied at any moment while the tube is functioning and shows the hardness of the rays. The radiometers of Cox and Hampson are illustrated which show the time and the iontometric measurement of the dose. Phosphorescent materials for protecting the body are described and methods of attaching them to the parts of the patient's body that is not to be irradiated. A form of writing roentgen prescriptions is given and the necessity of careful supervision in roentgen institutes emphasized. Physicians in general have not been very enthusiastic in adopting protection measures unless they themselves have had unfortunate experiences in injuring patients. This is a psychological problem but an effort should be made to make roentgenologists see the importance of protective measures.—*A. G. Morgan.*